Smolt Condition and Timing of Arrival at Lower Granite Reservoir

Annual Report 1987

U.S. Department of Energy
Bonneville Power Administration
Division of Fish & Wildlife

Idaho Department of
Fish and Game

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

For copies of this report, write to:

Bonneville Power Administration
Division of Fish and Wildlife - PJ
P.O. Box 3621
Portland, OR 97208

SMOLT CONDITION AND TIMING OF ARRIVAL AT LOWER GRANITE RESERVOIR

Annual Report

for 1987 Operations

by

Edwin W. Buettner, Sr. Fishery Research Biologist

and

V. Lance Nelson, Sr. Fishery Technician

Idaho Department of Fish and Game

Boise, ID 83707

Funded by

U.S. Department of Energy

Bonneville Power Administration

Division of Fish and Wildlife

Mr. Dale Johnson, Project Manager

Contract No. DE-AI79-83BP11631

Modification No. A006

Project No. 83-323 B

TASTE Of CONTENTS

LIST OF TABLES

Page

LIST Of TABLES (Continued)

LIST OF FIGURES

Page

Page

ABSTRACT

This project monitored the daily passage of smolts during the 1987 spring outmigration at three migrant traps; one each on the Snake, Clearwater, and Salmon rivers. Daily mark recapture, species composition, and total catch were provided to the Fish Passage Center and other agencies interested in juvenile chinook salmon and steelhead trout outmigration on a daily basis for water budget and passage management decisions.

Average travel time for PIT-tagged chinook salmon smolts from the head of Lower Granite Reservoir to Lower Granite Dam was 18 days prior to April 15 and 5 days after April 22. PIT-tagged hatchery steelhead trout average travel time from the head of Lower Granite Reservoir to Lower Granite Dam was about 9.5 days for a brief period early in the migration season and 4.5 days for the majority of the migration season. Wild steelhead trout average travel time from the head of Lower Granite Reservoir to Lower Granite Dam was 3.5 days during the migration season.

The chinook salmon smolt migration begins in earnest when Salmon River discharge makes a significant rise in early to mid-April. Most yearling chinook salmon pass into Lower Granite Reservoir in April, followed by passage of steelhead trout in May. Chinook salmon smolt recapture data from the Snake River trap suggests a strong dependence of migration rate in the free flowing portions of the rivers above Lower Granite Reservoir on quantity of Snake and Salmon River discharge, although no statistical correlation can be shown at this time.

Daily and seasonal descaling rates were calculated for each species at each trap. Descaling rates were highest for hatchery steelhead trout, intermediate for yearling chinook salmon, and lowest for wild steelhead trout. Descaling rates were generally higher in 1987 than those observed in 1984 through 1986.

The steelhead radio tagging study showed that only 71 of the radio-tagged steelhead passed under the span of the Interstate Bridge that the Snake River trap was attached to and 301 passed under one span of the Interstate Bridge just east of the drawbridge section in 1987. The study showed that on the Clearwater River, radio-tagged steelhead passed close to the trap and that there may be some avoidance of the trap.

INTRODUCTION

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) directed the Northwest Power Planning Council (NWPPC) to develop programs to mitigate for fish and wildlife losses in the Columbia River basin resulting from hydroelectric projects. Section 4(h) of the Act explicitly gives the Bonneville Power Administration (BPA) the authority and responsibility to use its resources "to protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project on the Columbia River system."

Water storage and regulation for hydroelectric generation severely reduces flows necessary for downstream smolt migration. In response to the Columbia Basin Fish and Wildlife Authority (CBFWA) recommendations for migration flows, the NWPPC Columbia River Basin Fish and Wildlife Program proposed a "water budget" for augmenting spring flows.

The Northwest Power Planning Council's water budget in the Columbia's Snake River tributary is 1.19 million acre-feet of stored water for use between April 15 and June 15 to provide improved passage and migration conditions.

To provide information to the Fish Passage Center (FPC) on smolt movement prior to arrival at the lower Snake River dams and reservoirs, the Idaho Department of Fish and Game (IDFG) monitors the daily passage of smolts at the head of Lower Granite Reservoir and 164 kilometers upriver at White Bird, Idaho, on the Salmon River. The Salmon River trap is operated only during low runoff years. This information allows the FPC to optimize the use of the limited Snake River water budget.

Additionally, the IDFG smolt monitoring project collects data on relative species composition, estimated fish passage index, hatchery steelhead trout vs. wild (natural) steelhead trout ratios, travel time, migration rate, and smolt condition relative to scale loss. By monitoring smolt passage at Lower Granite Dam and at the head of Lower Granite Reservoir, migration rates under riverine and reservoir conditions can be estimated and compared under various flow and temperature conditions. By having monitoring sites on both the Snake and Clearwater arms of Lower Granite Reservoir, the migration timing of smolts from each drainage can be determined individually. Also, the relative composition of hatchery and wild stocks of steelhead trout can be determined--information useful to document the rebuilding of wild stocks which is being undertaken in other NWPPC projects. Wild/hatchery ratios for steelhead trout at the Clearwater River trap cannot be used because a large portion of the wild fish migrate prior to the release of hatchery fish and the trap is out of service when flows exceed 35,000 cfs. This allows for a disproportionate collection of wild or hatchery steelhead, depending on when the trap was out of service.

Smolt monitoring is beneficial for water budget management under all flow conditions but most valuable in low flow conditions, when migration rates are slower than during normal or above normal run-off years. In low flow years, knowledge of when most smolts have left tributaries and entered areas which can be affected by releases of stored waters allows managers to make the most timely use of the limited water budget resource. Project personnel continually strive to improve smolt trap design and location in years prior to such a low water condition to assure the best possible information is provided for water budget management purposes which will maximize smolt survival. Within the duration of the Smolt Monitoring Project, only one such low flow year has been experienced: 1987. Indications are that judicious use of the water budget can greatly enhance the migration timing and rate of juvenile chinook salmon and steelhead trout.

OBJECTIVES

1. Determine timing of the outmigration for the various groups of hatchery-produced and wild chinook salmon and steelhead trout smolts as they leave the Salmon River drainage during low flow years.

2. Establish smolt travel time from the Salmon River index site at White Bird and from release sites to the index sites at the upper end of Lower Granite Reservoir.

3. Correlate travel time with river flows from index sites to Lower Granite Reservoir and Lower Granite Dam.

4. Determine where, when, and to what extent descaling occurs to hatchery-reared chinook salmon and steelhead trout smolts released upstream from Lower Granite Dam and develop management alternatives to reduce scale loss.

METHODS

Releases of Hatchery-Produced Smolts

We obtained information from hatcheries which release steelhead trout and chinook salmon juveniles in the Snake River system upstream from Lower Granite Dam. This information included species, number released, time and location of release, and the group identifying freeze brand, if used. This allowed us to anticipate the passage of the various release groups and branded fish at downriver trapping sites.

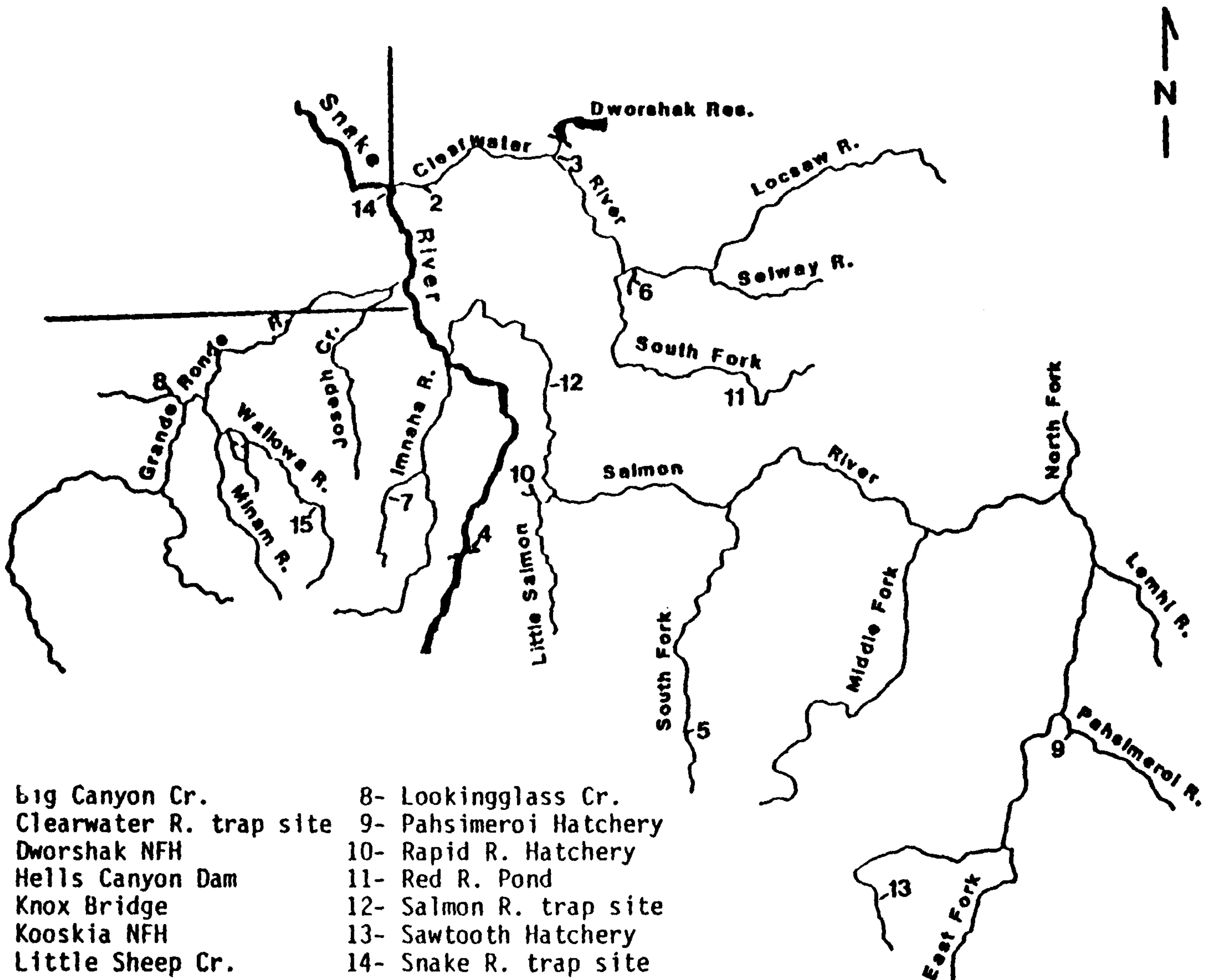
Smolt Monitoring Traps

During the 1987 outmigration, three smolt monitoring traps were employed to monitor the passage of juvenile chinook salmon and steelhead trout. One scoop trap (Raymond and Collins 1974) was stationed on the Clearwater River and one was stationed on the Salmon River. A dipper trap (Mason 1966) was located on the Snake River (Fig. 1). Trap-caught smolts were removed daily from the traps for examination, enumeration, and release back to the river. When available, between 150 to 300 chinook salmon and steelhead trout smolts were examined each day for scale loss. Up to 2,000 smolts were examined daily for hatchery brands. The remaining catch was enumerated by species and released. Prior to examination for scale loss and freeze brands, fish were anesthetized with Tricaine Methanesulfonate (MS-222). These fish were allowed to recover from anesthesia before being returned to the river.

To quantify scale loss, each side of a smolt was separated into five areas and each area was examined (Koski et al. 1986). An area was considered "descaled" if 402 or more of the scales within the area were missing. If at least two areas on one side of a fish were descaled, then the fish was considered descaled. Scale loss of this degree is often referred to as "standard" descaling. Additionally, beginning in 1985, a fish was considered to have standard descaling if a band of scales was missing from at least one side of a fish and the amount of missing scales was equal to or greater than the loss of 40% or more scales from two areas on a side of a fish as described above. This type of descaling is known as Number "9" descaling.

A second descaling classification is "scattered" descaling, which occurs when at least 102 of the scales were missing from at least one side of the fish. A third descaling classification is "two-area" descaling, which exists when the sum of the number of the ten areas on a fish (Fig. 2) which are at least 40X descaled and the number of sides of a fish which exhibit scattered descaling equals two or more. The two-area classification includes fish that exhibit standard descaling, as well as fish that would not meet the criteria for the standard category because there was only one descaled area per side. This type of descaling is likely to be as detrimental to fish health as standard descaling.

At each trap, water temperature and turbidity were recorded each day using a centigrade thermometer and 20 cm Secchi disc. The U.S. Weather Service provided daily information on river discharge. .The Snake River trap discharge was measured at the USGS Anatone gauge (113334300). The Clearwater River trap discharge was measured at the USGS Spalding gauge (113342500). The Salmon River trap discharge was measured at the USGS White Bird gauge (113317000).



1- Big Canyon Cr.
2- Clearwater R. trap site
3- Dworshak NFH
4- Hells Canyon Dam
5- Knox Bridge
6- Kooskia NFH
7- Little Sheep Cr.
8- Lookingglass Cr.
9- Pahsimeroi Hatchery
10- Rapid R. Hatchery
11- Red R. Pond
12- Salmon R. trap site
13- Sawtooth Hatchery
14- Snake R. trap site
15- Spring Cr.

Figure 1. Map of study area.

TRAP_JUVENILE_DESCALING_FORM (RECORDER_____________)

DATE__________ SITE____________ TIME____________ SECCHI DISC______.___M

H2O TEMP______.___C VELOCITY______ TRAP POSITION______________________

Efficiency_Tests: Trap down time (hrs)_____________
(# fish marked/released and mark used)
Chinook_______________ SH_______________ SW_______________

Remarks: ____

DESACALING

RIGHT LEFT

6. SCATTERED____ 7. EYE/HEAD INJURIES_____ 8. DEAD____ 9. DESCALED BAND

	CHIN	STEEL		CHIN	STEEL		CHIN	STEEL		CHIN	STEEL
	descale	brand		descale	brand		descale	brand		descale	brand
1.			1.			1.			1.		
2.			2.			2.			2.		
3.			3.			3.			3.		
4.			4.			4.			4.		
5.			5.			5.			5.		
6.			6.			6.			6.		
7.			7.			7.			7.		
8.			8.			8.			8.		
9.			9.			9.			9.		
10.			10.			10.			10.		
11.			11.			11.			11.		
12.			12.			12.			12.		
13.			13.			13.			13.		
14.			14.			14.			14.		
15.			15.			15.			15.		
16.			16.			16.			16.		
17.			17.			17.			17.		
18.			18.			18.			18.		
19.			19.			19.			19.		
20.			20.			20.			20.		
21.			21.			21.			21.		
22.			22.			22.			22.		
23.			23.			23.			23.		
24.			24.			24.			24.		
25.			25.			25.			25.		

FISH SAMPLED: CHINOOK________ HATCHERY STEEL________ WILD STEEL________

Form: TJD-88

Figure 2. Form used to record smolt passage and descaling information. Drawings show the five areas on each side of a smolt which are considered independently for scale loss.

Salmon River Trap

Information during near normal to above normal flow years is available at the Salmon River trap for 1983, 1984, and 1985. Therefore, this trap is operated only if the February Soil Conservation Service - Snow Survey Streamflow Forecast at White Bird is less than 90% of the 25-year average. A tentative decision to operate the trap is made in early February using the January streamflow forecast. If the January forecast is below 902 of normal, preparation to operate the Salmon River trap will begin. The final decision is then made using the February forecast, available in early March.

The January streamflow forecast in 1987 was 68% of normal; by the first of March the prediction had fallen to 59% of normal. At this time, the decision to operate the Salmon River trap was made.

The trapping site for the Salmon River trap is located one kilometer downstream from the mouth of White Bird Creek (rkm 86). When river flows permit, the trap is situated on the outside of a bend in the river, near the south bank, immediately downstream from a rock shelf. This location was chosen because juvenile migrants are concentrated both laterally and vertically due to the morphology of the site, thus making them more vulnerable to capture. River width at this site is approximately 70 m and depth ranges from 2 m at 6,000 cfs to 5 m at 25,000 cfs. The trap was operated from March 5 until April 28, 1987, when high runoff forced termination of trap operations.

Chinook salmon smolts were freeze branded (Mighell 1969) and released at the Salmon River trap to estimate travel time from the lower Salmon River drainage to the head of Lower Granite Reservoir. The brand was changed at three-day intervals to document changes in travel time as environmental conditions changed. When available, up to 3,000 chinook salmon were branded daily with a goal of 6,000 per unique brand group. Nine unique freeze brands were used at the Salmon River trap during the 1987 field season on chinook salmon juveniles. Seven of the nine chinook salmon brand groups were also used for trap efficiency tests by transporting the marked fish one kilometer upstream from the trap site by boat and releasing them for subsequent recapture.

Capture rate of steelhead trout smolts at the Salmon River trap is considerably less than that of chinook salmon. Sufficient numbers of steelhead trout could not be obtained to determine trap efficiency and document travel time to downriver collection sites, as is done with the chinook salmon. Therefore, steelhead trout were freeze branded at Hagerman NFH and transported to the Salmon River and released approximately one kilometer upstream from the trap site. Three unique brand groups of steelhead trout, containing from 4,400 to 4,700 fish each, were released during the 1987 field season. These releases were also used to estimate trap efficiency at the Salmon River trap.

Snake River Trap

The Snake River migrant dipper trap was attached to the downstream side of the Interstate Bridge by steel cables. This location is at the head of Lower Granite Reservoir 0.5 km upstream from the confluence of the Snake and Clearwater rivers. River width and depth at this location are approximately 260 m and 12 in, respectively.

Trap operation in 1987 began February 28 and continued until June 29. There were no interruptions in trap operation due to mechanical breakdown or excessive runoff conditions.

Chinook salmon and steelhead trout smolts were PIT (Passive Integrated Transponder) tagged (Prentice et al. 1987) at the Snake River trap in 1987 to estimate travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Up to 300 chinook salmon and 60 steelhead trout (30 of which were wild fish, if available) were PIT-tagged daily. Individual daily release group travel time to Lower Granite Dam was correlated with flow present during the migration period to determine how changes in this parameter affected travel time of smolts through Lower Granite Pool.

Clearwater River Trap

The Clearwater River scoop trap was installed 10 km upstream from the river's mouth, 4.5 km upstream from the head of Lower Granite Reservoir. The river channel at this location forms a bend and is 150 to 200 m wide and 4 to 7 m deep, depending on discharge.

Trap operation began February 19, 1987 and continued until June 25 when trap operation was terminated for the season.

Trap efficiency tests were conducted periodically throughout the season by releasing marked smolts 7 km upriver from the trap site. When trap catch allowed, up to 2,000 chinook salmon were caudal clipped, and 2,000 steelhead trout were opercle punched and released upstream. These fish were held in trash cans supplied with oxygen and carried upstream to the release site by boat and released. In addition to these fish, six groups of chinook salmon of approximately 2,000 each and three groups of steelhead trout of approximately 4,000 each were freeze branded at Dworshak NFH and transported to the release site and released at one-week intervals during late April and May to estimate trap efficiency.

Descaling

Chinook salmon descaling rates were estimated at four of Idaho's chinook salmon hatcheries prior to smolt release. Descaling rates were also estimated at the time of release for the South Fork Salmon River off-hatchery release group (McCall Hatchery) and for the Crooked River and White Sands Creek off-hatchery release groups (Sawtooth Hatchery). Sawtooth Hatchery also releases chinook salmon smolts directly from the hatchery, as do Kooskia NFH, Dworshak NFH, Rapid River, and Pahsimeroi hatcheries. During 1987, Rapid River and Pahsimeroi hatcheries made releases of spring chinook salmon in 'the Snake River at Hells Canyon Dam; descaling data was not recorded from these groups at the release site.

Steelhead trout descaling rates were estimated at two of Idaho's hatcheries prior to release and at four release sites at the time of release.

Examination of 200 to 900 smolts from representative groups of chinook salmon and steelhead trout was conducted at selected hatcheries and again at release sites to estimate the percentage of smolts having significant scale loss. The condition of the smolts was compared with that observed at trapping sites along the migration routes where up to 300 chinook salmon and steelhead trout smolts were examined daily.

Trap Efficiency

To estimate the number of smolts passing a trap it is necessary to know what proportion of the migration is being sampled. Additionally, this proportion, which is the trapping efficiency, may change as river discharge changes. To create an equation which describes the relationship between discharge and efficiency, efficiency must be estimated several times through the range of discharge during which the trap is operated. A linear regression of efficiency on discharge is then calculated from the data, after which an efficiency can be estimated from a known discharge. The ratio of recaptures to marks released is the estimate of trap efficiency (TE - recaptures/marks released).

Several techniques were used to estimate trap efficiency in 1987. Trap efficiency tests are conducted every four days using trap-caught fish that were marked, transported back upstream, and released, if enough smolts are available to mark. During 1987, six groups of chinook salmon smolts of 2,000 fish each and three groups of steelhead trout smolts of 4,000 fish each were freeze branded and held at Dworshak NFH. These groups were released at one-week intervals upstream from the Clearwater River trap for efficiency tests. These groups were also used to determine travel time through Lower Granite Reservoir.

Trap-caught chinook were marked and used for efficiency tests at the Salmon River trap with groups of one to two thousand being released every four days, when available. Three groups of steelhead trout smolts, of approximately 4,500 fish each, were freeze branded and held at Hagerman NFH until transport to a release site on the Salmon River upstream from the trap site. These groups were released at approximately one-week intervals for trap efficiency tests on the

Salmon River trap, as well as to estimate travel time from the lower Salmon River drainage to the head of Lower Granite Reservoir and to Lower Granite Dam.

No trap efficiency tests were conducted at the Snake River trap in 1987 because of the low trap catch associated with the extremely low flow year.

Travel Time and Migration Rates

Migration statistics were calculated on hatchery release groups from release sites to trap sites. Travel time and migration rates through Lower Granite Reservoir were calculated using median arrival times at the Snake River trap and at Lower Granite Dam for hatchery brand groups and brand groups used for trap efficiency tests. Smolts were PIT tagged (Prentice et al. 1987) at the Snake River trap as an additional method to determine travel time, and daily individual arrival times were calculated at Lower Granite Dam collection facility. Early in the season, chinook were collected at the Clearwater River trap, transported to the Snake River trap for PIT tagging, and released. When adequate numbers of chinook were being collected at the Snake trap, transportation of chinook from the Clearwater River trap was discontinued. All steelhead that were PIT tagged were collected at the Snake River trap. Later in the season, when trap collection did not provide adequate numbers of chinook and steelhead, additional fish were collected immediately behind the Snake River trap with purse seine equipment.

Steelhead Trout Radio Tracking Study

The migrant dipper trap on the Snake River and the scoop traps on the Clearwater and Salmon rivers all effectively collect chinook salmon smolts in large enough numbers to meet project goals but are relatively ineffective at collecting steelhead trout smolts. It is uncertain whether low steelhead trout catch is due to trap avoidance or if the traps are not in the main migrational path of steelhead smolts. In 1987, a radio tracking study was conducted at the Snake and Clearwater River traps to determine if fish were avoiding the trap or if the trap could be moved to a more productive location. The objective of the study was to determine steelhead trout smolt reaction to the traps and horizontal distribution of the steelhead trout smolts in the vicinity of the traps. Fish to be radio tagged were taken from the Snake and Clearwater River traps.

A contract was developed with the Coastal Zone and Estuarine Studies Division of the National Marine Fisheries Service (NMFS), Seattle, Washington, for the services of their Radio Tracking Subtask (Liscom and Bartlett 1988). The study was initiated in mid-April and terminated in mid-May, 1987. Sixty juvenile steelhead trout were radio tagged and released in the Snake River, and 61 juvenile steelhead trout were radio tagged and released in the Clearwater River upstream from the trap sites, during a five- to six-day time period. Radio-tagged fish were individually tracked past each trap site and their path plotted in relation to fixed geographical locations (Fig. 3).

RESULTS AND DISCUSSION

Hatchery Releases

Chinook Salmon

Chinook salmon released into the Snake River drainage above Lower Granite Dam were reared at seven locations in Idaho and one in Oregon. Washington Department of Fisheries made no release of chinook salmon juveniles in the Snake River drainage upstream from Lower Granite Dam that contributed to the 1987 outmigration. A total of 11,291,583 chinook salmon smolts were released at 15 locations in Idaho and Oregon (Table 1).

Sawtooth Hatchery made three releases of spring chinook salmon in the Clearwater River drainage at Red River, Crooked River, and White Sands Creek in the fall of 1986 for a total 696,120 fish. Lookingglass Hatchery also made **a** fall release of 328,161 spring chinook salmon juveniles at Lookingglass Creek, Oregon, in 1986. All other chinook salmon releases for the 1987 outmigration were made in the spring of 1987.

Steelhead Trout

Steelhead trout were reared at three hatcheries in Idaho, one in Washington, and one in Oregon for release upriver from Lower Granite Dam. A total of 7,436,384 steelhead trout smolts were released at 14 locations in Idaho, 10 locations in Oregon, and 3 locations in Washington (Table 2).

Niagara Springs Hatchery released 39,995 steelhead trout juveniles in the Snake River at Hells Canyon during the fall of 1986. The remainder of steelhead trout releases contributing to the 1987 outmigration occurred in the spring of 1987.

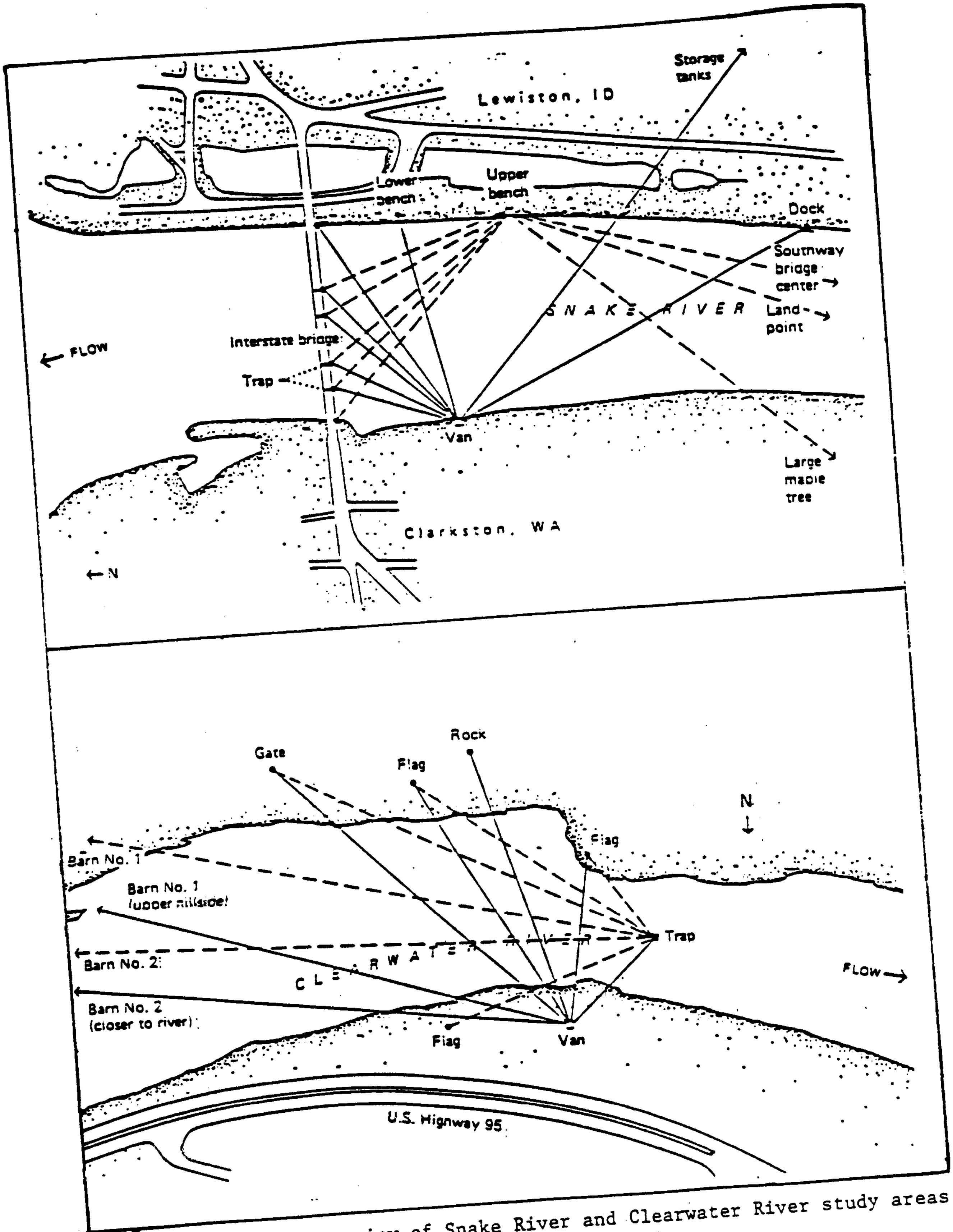


Figure 3. Diagrammatic view of Snake River and Clearwater River study areas showing grid lines used for radio tracking.

Table 1. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam, 1987.

Release site (hatchery)	Stock	Release date	No. released (No. branded)	Brand
Salmon River				
Sawtooth Hat.	Spring	3/13	1,081,400	
(Sawtooth)		(3/13)	(58,400)	RDR-1
		10/10/86	103,661	
E.F. Salmon R. (Sawtooth)	Spring	3/17-19	195,100	
S.F. Salmon R.	Summer	3/30-4/2	958,300	
(McCall)		(3/31)	(56,500)	LDR-3
Pahsimeroi R. (Pahsimeroi)	Summer	3/23	258,600	
Rapid River	Spring	3/18-4/7	2,836,400	
(Rapid River)		{3/27)	(53,500)	LDR-2 **
	Drainage Total		5,433,461	
Snake River and Non-Idaho Tributaries				
Hells Canyon	Spring	3/23	103,000	
(Rapid River)		(3/23)	(51,350)	LDR-4 **
Hells Canyon (Pahsimeroi)	Spring	3/2-6	444,700	
Lookingglass Cr.	Spring	4/1-5/20	855,658	
(Lookingglass)		(4/1)	(20,194)	LAJ-2
		(4/1)	(20,415)	LAJ-4
		(4/20)	(20,925)	LDJ-1
		(4/20)	(20,890)	LDJ-3
		(5/20)	(20,303)	LDJ-2
		(5/20)	(20,375)	LDJ-4
Lookingglass Cr.	Spring	9/24 & 11/1	328,161	
(Lookingglass)		(9/24)	(20,431)	LAJ-1
		(9/24)	(20,522)	LAJ-3
Grande Ronde (R2) (Lookingglass)	Spring	4/6	111,711	
Catherine Creek (Lookingglass)	Spring	2/26	88,667	

Table 1. Continued

Release site (hatchery)	Stock	Release date	No. released (No. branded)	Brand
Big Canyon Creek (Lookingglass)	Spring	3/30	84,295	
	Drainage Total		2,016,192	
Clearwater River				
Red River Pond (Sawtooth)	Spring	3/18 10/8/86	98,800 96,400	
Crooked River (Sawtooth)	Spring	3/16,18 10/8,15/86	227,500 251,300	
White Sands Creek (Sawtooth)	Spring	3/16/18 10/7,14/86	344,900 348,420	
N.F. Clearwater (Dworshak NPH)	Spring	4/1-2 (4/2)	1,710,710 (61,580)	RAR-1
Clear Creek (Kooskia NFH)	Spring	3/24	763,900	
	Drainage Total		3,841,930	
	Grand Total		11,291,583	

** Brand groups mixed at hatchery prior to transport

Table 2. Hatchery steelhead trout released into the Snake River system upriver from Lower Granite Dam, 1987.

Release site (hatchery)	Stock	Release date	No. released (No. brapded)	Brand
Salmon River				
Pahsimeroi River (Niagara Springs)	A	3/30-4/9	712,200	
Panther Creek (Niagara Springs)	A	4/9-13	299,700	
E.F. Salmon River (Hagerman NPH)	B	3/27-4/15	485,078	
		(4/8)	(52,811)	RDR-
Hazard Creek (Hagerman NFH)	A	4/16-30	299,098	
		(4/30)	(4,522)	LDK-
Sawtooth Hatchery (Hagerman NFH)	A	3/26-4/15	687,634	
		(4/14)	(51,887)	RDR-
Slate Creek (Hagerman NFH)	B	3/24	49,740	
Salmon R.@Deer Cr.	B	4/8-22	13,801	
		(4/8)	(4,700)	LDK-
		(4/22)	(4,690)	LDK-
		(4/15)	(4,408)	LDK-
	Drainage Total		2,547,251	
Snake River and Non-Idaho Tributaries				
Hells Canyon (Niagara Springs)	A	3/23-30	800,000	
		(3/26)	(51,600)	LDR-1
Hells Canyon (Niagara Springs)	A	10/21/86	39,995	
Little Sheep Cr. (Irrigon)	A	5/1-5	93,716	
		(5/3)	(15,642)	LW-4
		(5/2)	(15,660)	RDJ-4
Spring Creek (Irrigon)	A	4/24-28	587,406	
		(4/26)	(14,638)	LDJ-1
		(4/26)	(14,598)	LDJ-3
		(4/26)	(14,485)	RDJ-1
		(4/26)	(14,534)	RDJ-3
Grande Ronde (R1) (Irrigon)	A	4/15-23	151,053	

Table 2. Continued

Release site (hatchery)	Stock	Release date	No. released (No. branded)	Brand
Wildcat Creek (Irrigon)	A	4/28-29	52,335	
Grande Ronde (R2) (Irrigon)	A	4/8-24	291,332	
Catherine Creek (Irrigon)	A	4/13-27	72,438	
Wallowa River (Irrigon)	A	4/14-30	160,032	
Big Canyon Creek (Irrigon)	A	4/25	222,526	
Prairie Creek (Irrigon)	A	4/29	24,257	
Hurricane Creek (Irrigon)	A	4/29	12,000	
Cottonwood Cr. (Lyonns Ferry)	A	4/20-30	200,845	
		(4/26)	(20,099)	RAIC-1
		(4/26)	(20,083)	RAIC-2
		(4/26)	(20,115)	RAIC-3
		(4/26)	(20,164)	RAIC-4
Asotin Creek (Lyonns Ferry)	A	4/22	22,950	
Whisky Creek (Lyonns Ferry)	A	4/28-29	52,500	
	Drainage Total		2,783,385	
Clearwater River				
Clearwater River (Dworshak NFH)	B	4/20-23	1,206,580	
		(4/22)	(58,508)	RDR-3
		(5/5)	(4,073)	MK-3
S.F. Clearwater R. (Dworshak NFH)	B	4/13-17	298,070	
Newsome Creek (Dworshak NFH)	B	4/14-17	202,857	
American River (Dworshak NFH)	B	4/14-17	41,527	

Table 2. Continued

Release site (hatchery)	Stock	Release date	No. released (No. branded)	Brand
Clear Creek (Dworshak NFH)	B	4/13-17 (4/17)	156,552 (33,897)	RAR-3
Crooked River (Dworshak NFH)	B	4/13-17 (4/14)	200,162 (48,557)	LAR-3
	Drainage Total		2,105,748	
	Grand Total		7,436,384	

Smolt Monitoring Traps

Snake River Trap Operation

The Snake River trap was operated from February 28 through June 29, 1987. Trap catch during this period was 1,887 yearling chinook salmon, 56 sub-yearling chinook salmon, 935 wild steelhead trout, 8,754 hatchery steelhead trout, and 5 sockeye salmon.

The majority of the chinook salmon (57%) were captured during May; sub-yearling chinook salmon (chinook smolts less than 80 millimeters) passage began in mid-March and peaked the first week of May. Fifty-five percent of the steelhead trout were captured during June (Figs. 4 and 5). Wild steelhead trout passed earlier, 46% in May and 34% in June, than did hatchery steelhead trout, 36% in May and 57% in June. The ratio of wild and hatchery steelhead trout in the catch was 1:9.

The chinook salmon catch at the Snake River trap was less than 10% of the 1984-1986 average. There appears to be a threshold velocity at the mouth of the trap; below this threshold the trap is relatively ineffective at collecting fish. Chinook catch was effected the greatest because velocities were very low during the majority of the chinook outmigration. Velocities were generally higher during the steelhead trout outmigration.

Snake River discharge, measured at the Anatone gauge, ranged from 16,860 cfs to 34,440 cfs in March (Fig. 4). The average April discharge was 26,310 cfs, with a peak of 42,210 cfs April 30. The season peak discharge of 57,090 occurred May 14. From that time until the end of the trap operation, the discharge decreased steadily to 17,000 cfs.

Water temperature in the Snake River when trap operation began, February 28, was 2^0 C and increased to 7° C by the end of March (Fig. 6). By the end of the trapping season, June 29, water temperature had risen to 20.5° C.

Secchi disc transparency fluctuated throughout the sampling season (Fig. 6). Influenced mainly by localized rain or thunderstorm events, the secchi transparency shows no obvious correlation to changes in discharge.

Clearwater River Trap Operation

The Clearwater River trap operated from February 19 through April 29 and again from May 20 until June 25. During the period April 30 to May 19, trap operation was suspended due to high discharge in the Clearwater River.

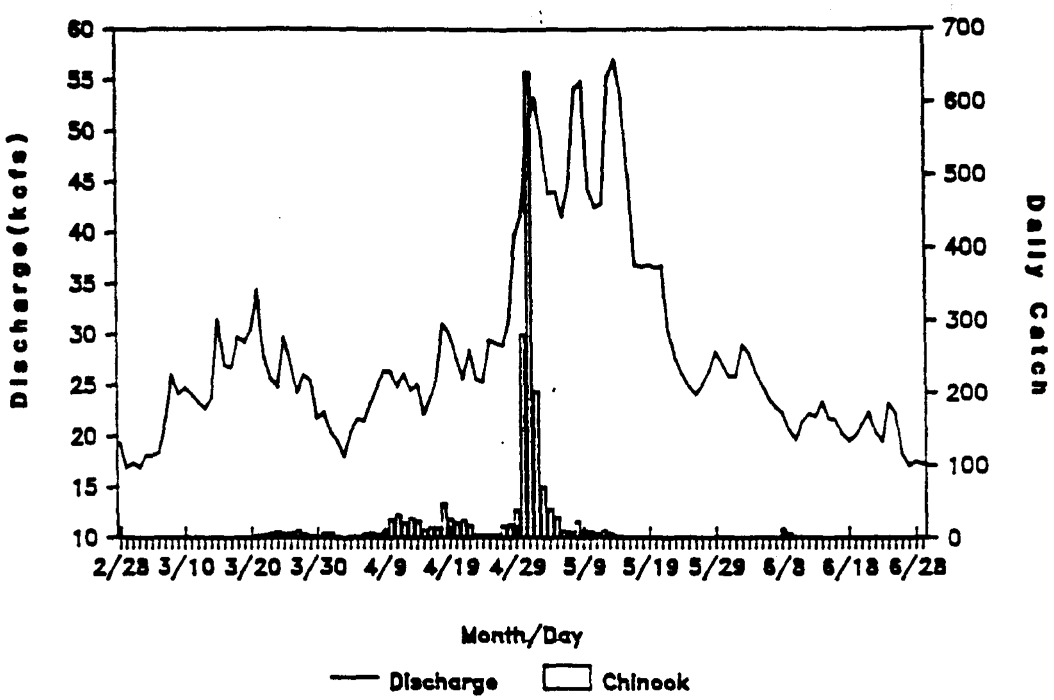
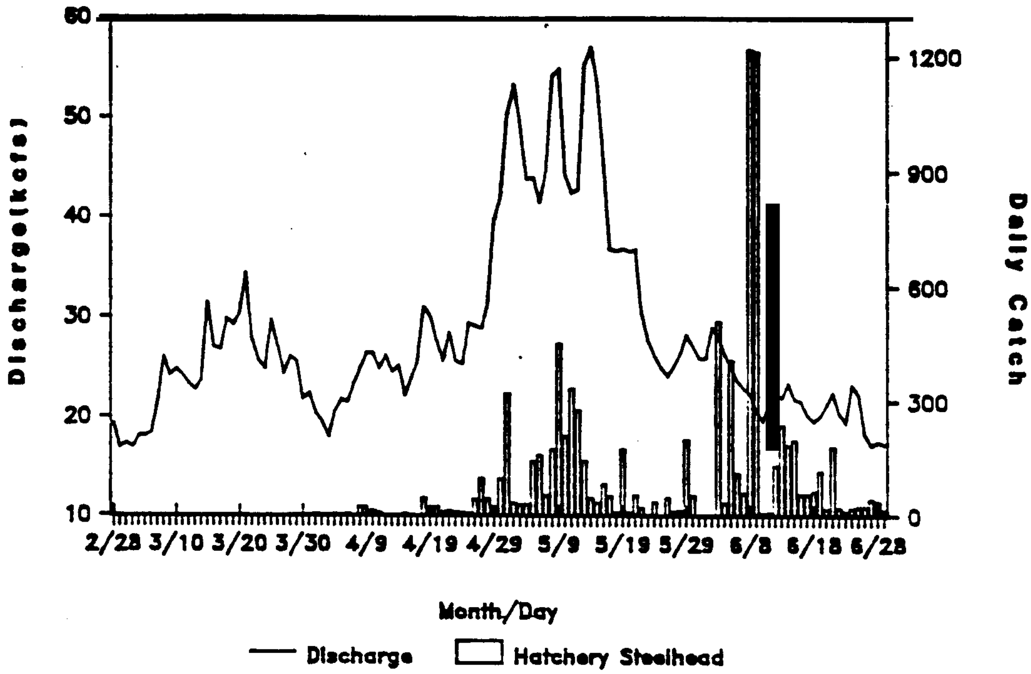


Figure 4. Snake River trap daily catch for yearling chinook salmon overlaid by Snake River discharge, 1987.



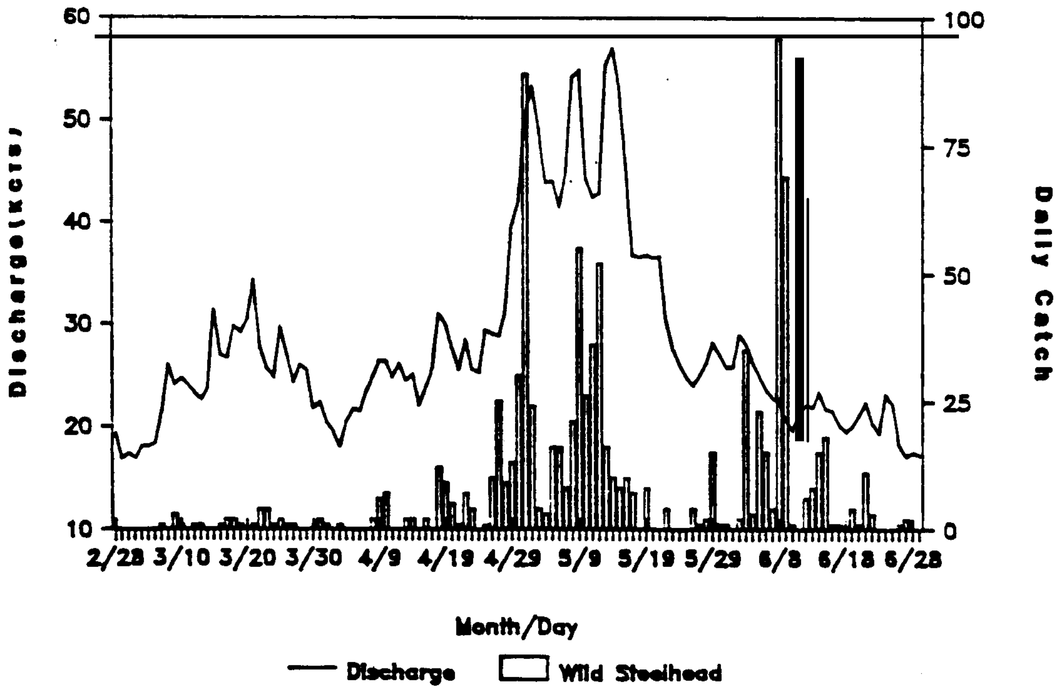
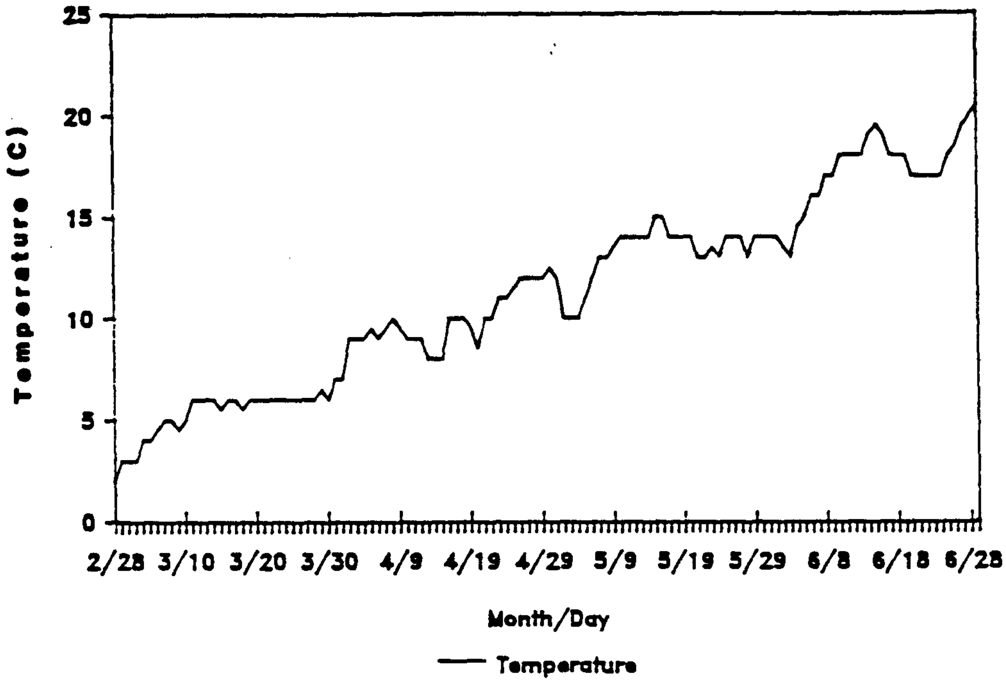


Figure 5. Snake River trap daily catch for wild steelhead trout and hatchery steelhead trout overlaid by Snake River discharge, 1987.



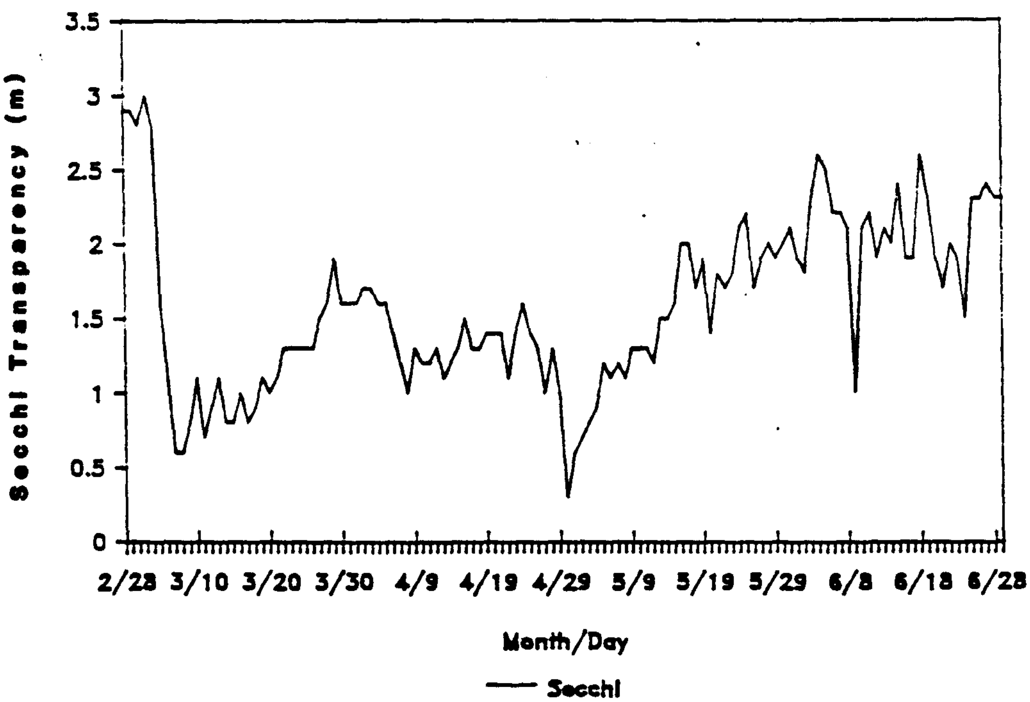


Figure 6. Daily temperature and secchi disk transparency at the Snake River trap, 1987.

The Clearwater River trap captured 72,707 chinook salmon, of which 34 were classed as sub-yearling and the remainder were yearlings; 5,567 hatchery steelhead trout; and 896 wild steelhead trout in 1987. Two peaks of chinook salmon passage were observed at the Clearwater River trap. The first peak in late March, prior to the Dworshak NFH release, was presumed to be from the Sawtooth Hatchery releases made in Red River, Crooked River, and White Sands Creek, and the Kooskia NFH release made in Clear Creek. The second peak was comprised of the Dworshak NFH release made in the North Fork of the Clearwater River (Fig. 7).

The ratio of wild to hatchery steelhead trout in the Clearwater River catch was approximately 1:6. Trap catches of steelhead trout on the Clearwater River peaked the third week of April, coinciding with the release of Dworshak NFH steelhead trout smolts from the hatchery and from off-hatchery planting sites (Fig. 8).

Water temperature at the Clearwater River trap ranged from a low of 3° C the beginning of the season, February 19, and rose to 10^0 C by the second week of April (Fig. 9). The high temperature for the season of 19.5^0 C was recorded June 15.

Discharge during the first two months of operation ranged from 3,760 cfs to 16,000 cfs (Fig. 7). A small peak in the hydrograph was seen in late April and early May when discharge reached 44,680 cfs and then dropped back to approximately 15,000 cfs for the remainder of the trapping season. During this period of high runoff, April 30 to May 19, the Clearwater River trap was not operated.

Secchi disc transparency in the Clearwater River fluctuated throughout the trapping season and ranged from near 0.5 meters to 2 meters and greater (Fig. 9).

Salmon River Trap Operation

The March streamflow forecast for the Salmon River drainage above White Bird was 56% of normal, which fell well below the 90% criteria established for determining which years the Salmon River trap would be operated. Trap operation was initiated March 5 and terminated April 28. During this period, the trap captured 51,557 yearling chinook salmon, 46 sub-yearling chinook salmon, 598 wild steelhead trout, and 615 hatchery steelhead trout. Essentially, all (96%) of the chinook passage occurred in April at the Salmon River trap, with the peak occurring mid-month (Fig. 10). Both wild and hatchery steelhead trout passage at the Salmon River trap also occurred in April (98%), with the peak occurring at the end of the month (Fig. 11). Unlike the Snake and Clearwater River traps the Salmon River trap ratio of wild to hatchery steelhead trout was approximately 1:1.

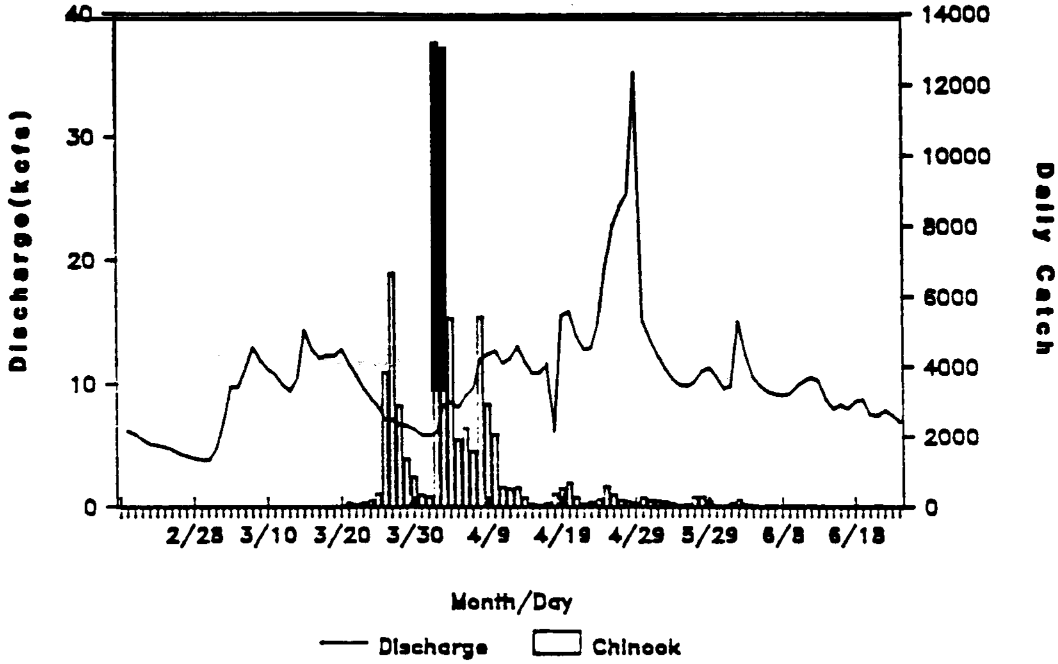


Figure 7. Clearwater River trap daily catch for yearling chinook salr
overlaid by Clearwater River discharge, 1987.

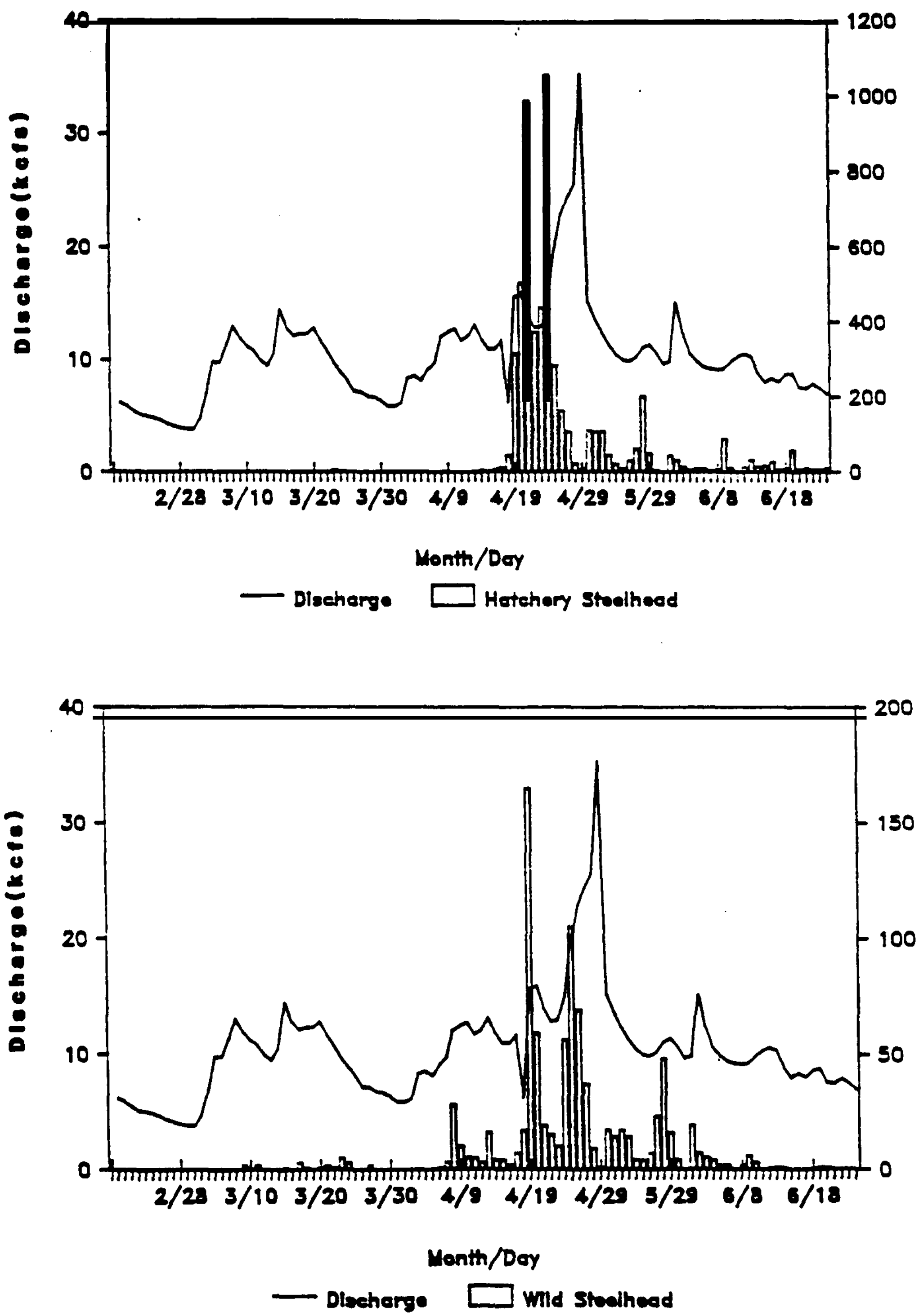
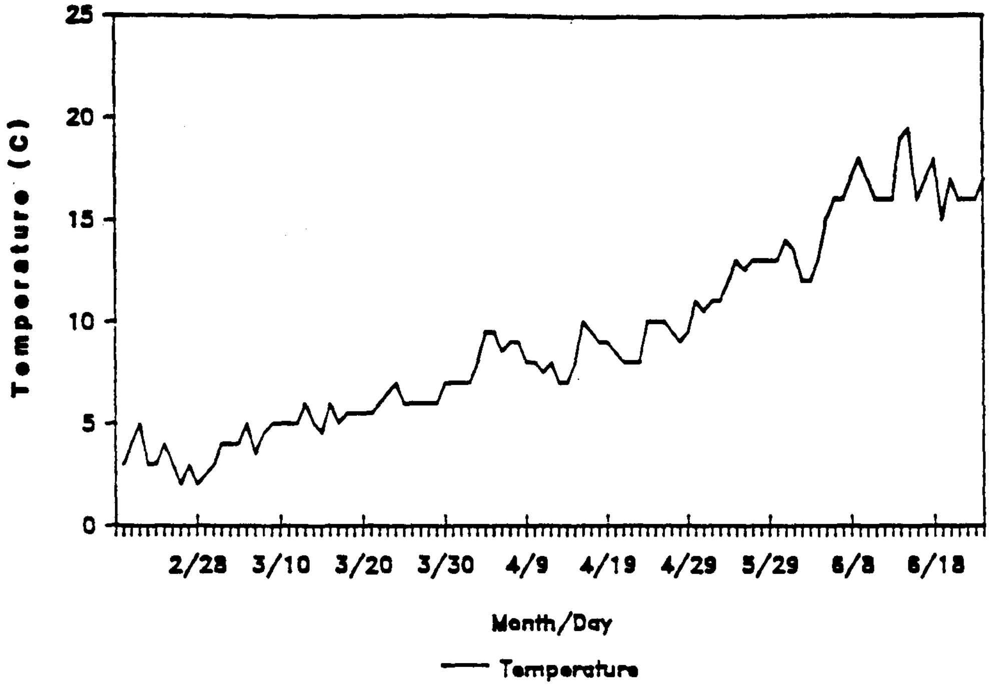


Figure 8. Clearwater River trap daily catch for wild steelhead and hatchery steelhead trout overlaid by Clearwater discharge, 1987.



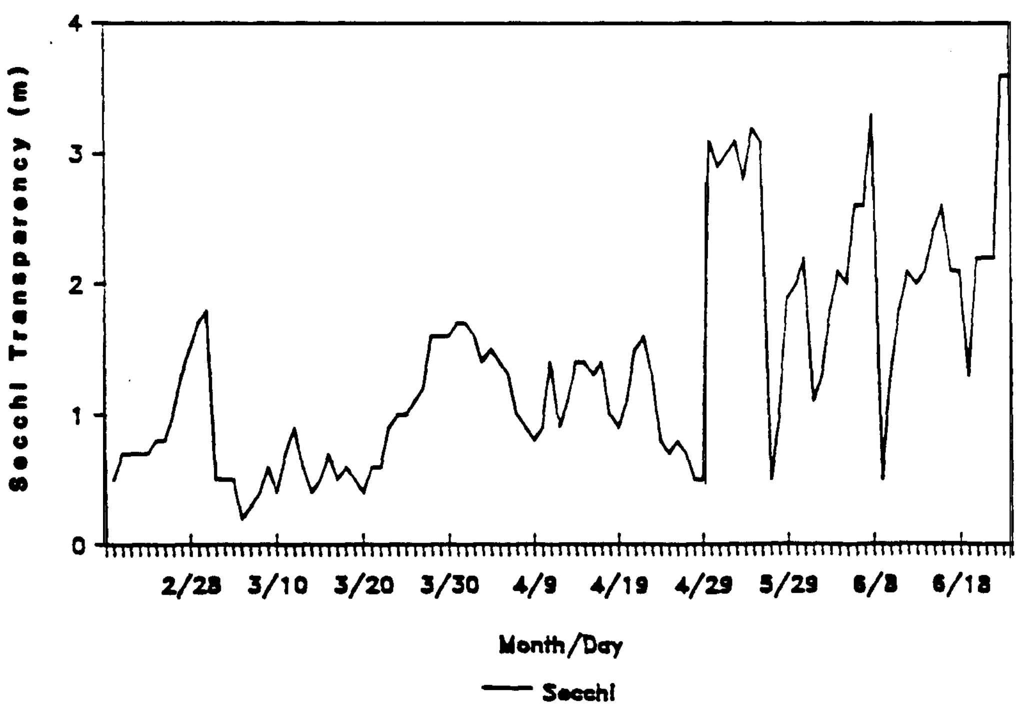


Figure 9. Daily temperature and secchi disk transparency at the Clearwater River trap, 1987.

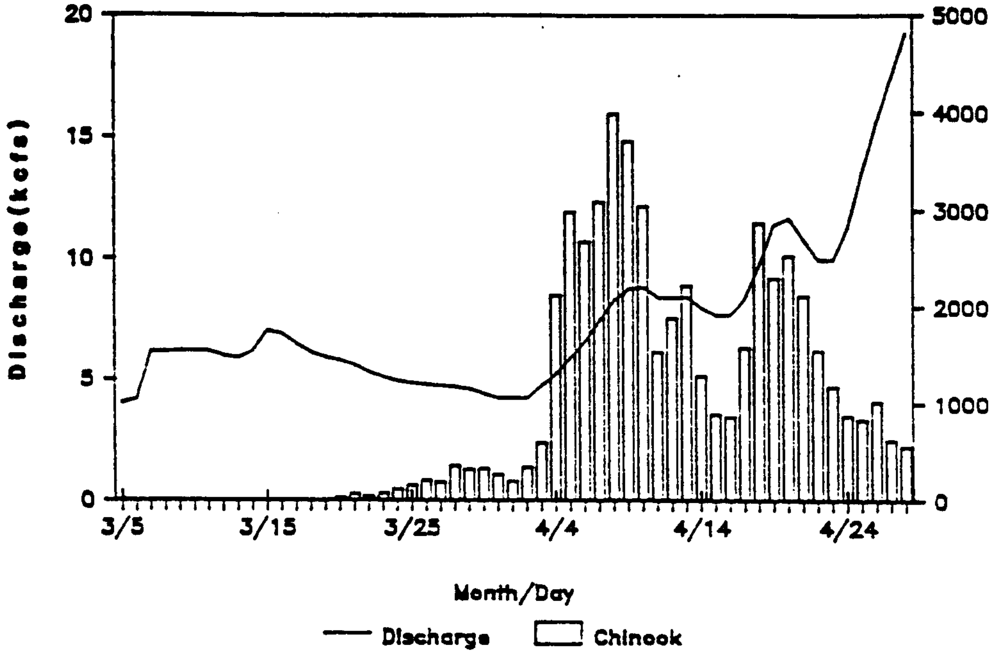
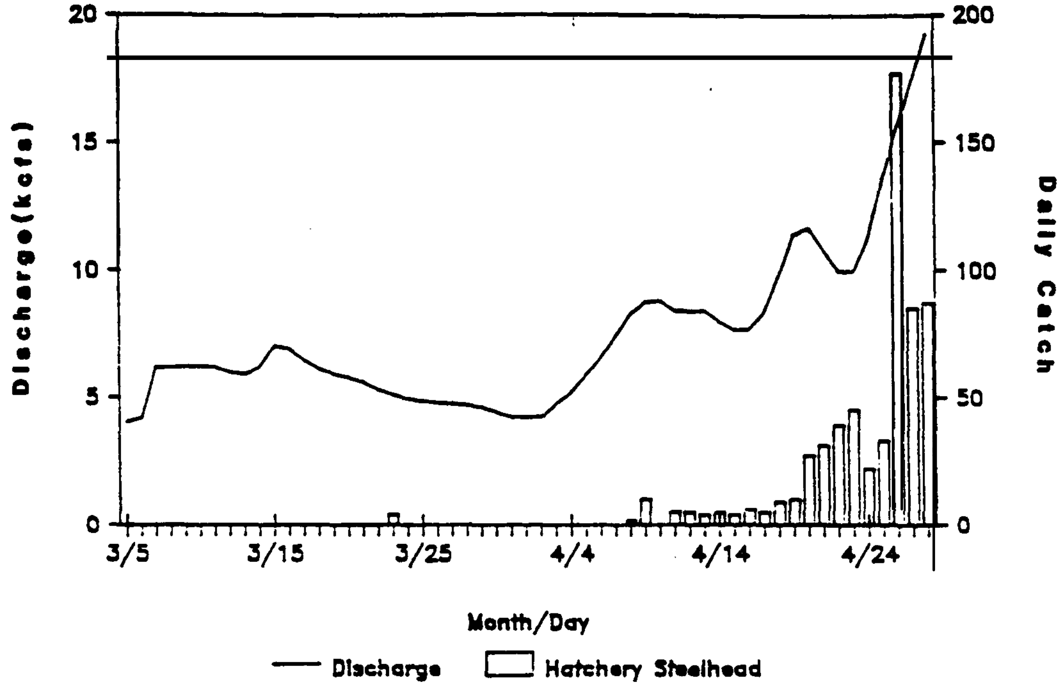


Figure 10. Salmon River trap daily catch for yearling chinook s overlaid by Salmon River discharge, 1987.



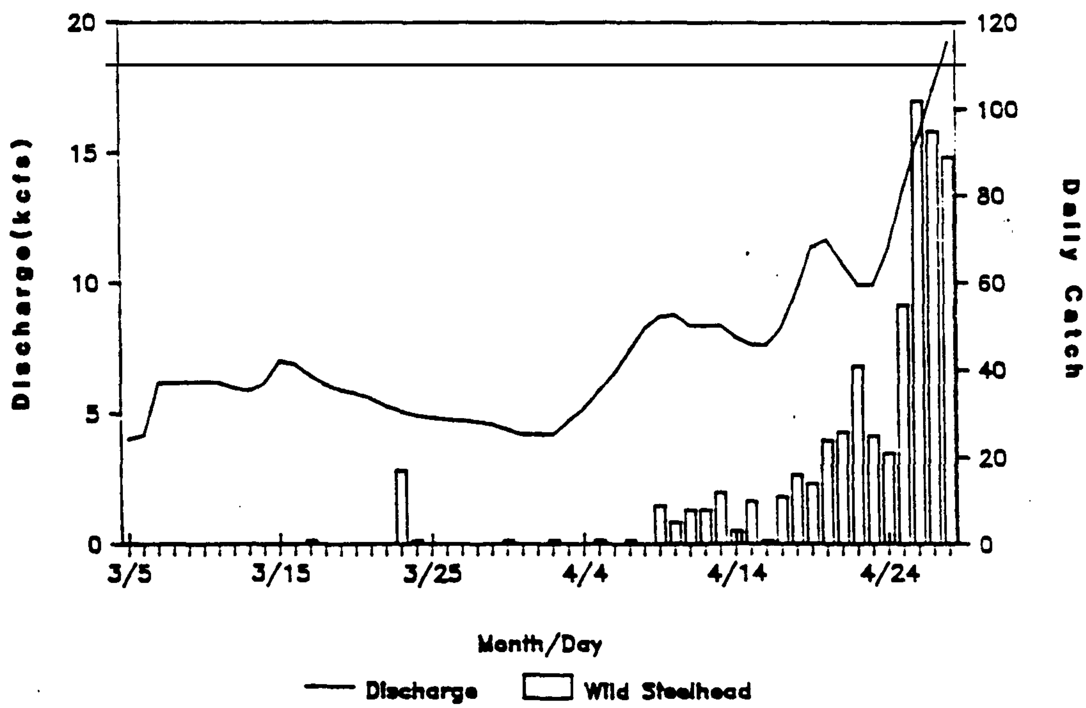


Figure 11. Salmon River trap daily catch for wild steelhead trout and hatchery steelhead trout overlaid by Salmon River discharge, 1987.

Discharge in the Salmon River, measured at the White Bird gauge, ranged from 4,050 cfs at the beginning of the trapping season, to 19,240 cfs when trapping was discontinued for the year, April 28 (Fig. 10). The average discharge for the majority of the season was below 8,000 cfs.

Water temperature in the Salmon River at the beginning of the trap **operation** was 5.5° C, March 5, and increased to 7.0° C by the end of March. When trap operation was discontinued for the season, the water temperature had risen to 12° C (Fig. 12).

Secchi disc transparency fluctuated throughout the season, ranging from 0.6 meters to 3 meters (Fig. 12).

Descaling

Descaling of Chinook Salmon Smolts at Hatcheries and Release Sites

The standard descaling rate at four of Idaho's chinook salmon hatcheries in the spring of 1987 was 0.32 (Table 3). This is the lowest descaling rate yet observed at Idaho hatcheries since the inception of the monitoring process in 1983.

Standard descaling of chinook salmon from Sawtooth Hatchery at two observed off-hatchery release sites, Crooked River and White Sands Creek, was 0.6%. Descaling rates were not estimated at Sawtooth Hatchery prior to transport but from past years' averages there appears to be little, if any, increase in descaling due to transport from hatcheries to release sites in either of these release groups.

The off-site releases of McCall Hatchery chinook salmon in the South Fork of the Salmon River at Knox Bridge showed no increase in standard descaling rates from that observed at the hatchery prior to transport (Table 3).

Chinook salmon "scattered" descaling at the hatcheries ranged from 0% at Dworshak NFH to 4.6% at Kooskia NFH. McCall Hatchery showed 1.2% and Rapid River Hatchery, 1.8%. Scattered descaling at the observed off-hatchery release sites was 0.3% at the South Fork of the Salmon River release (McCall Hatchery), 5.6% at the Crooked River release, and 6.7% at the White Sands Creek (Sawtooth Hatchery) release. There was no comparison available to on-hatchery descaling rates for the Crooked River and White Sands Creek releases, but the South Fork Salmon River release site descaling rate, compared to the McCall Hatchery descaling rate (hatchery of origin), actually showed a decrease in scattered descaling of fourfold in the transported group. This inverse difference was only 0.9% and is attributed to natural variability between samples due to small sample size (Table 3).

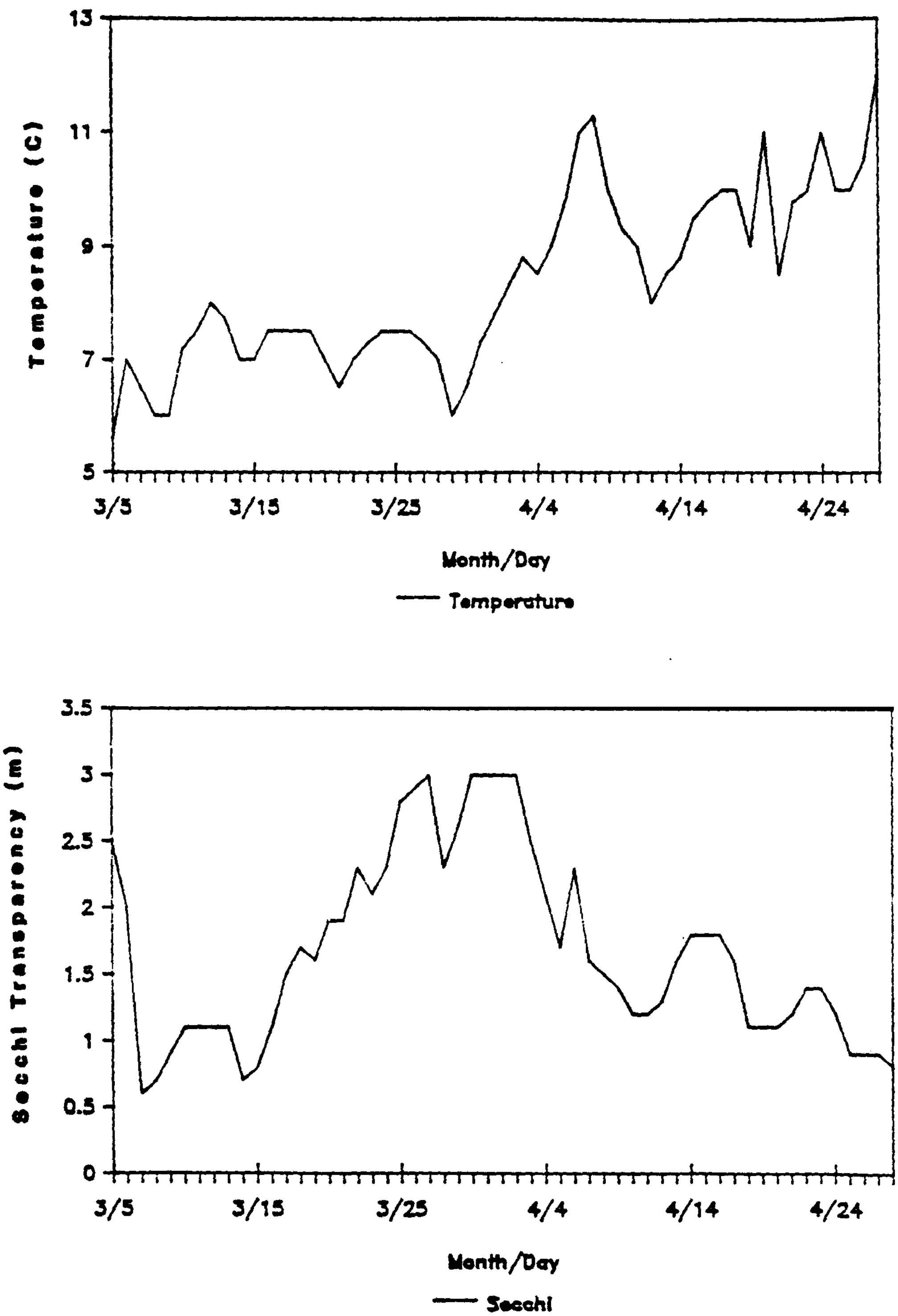


Figure 12. Daily temperature and secchi disk transparency at the Salmon River trap, 1987.

Two-area descaling at DNFH was the same as standard descaling, 0.32; three other chinook salmon hatcheries in Idaho showed increases of less than 1.5% in two-area descaling over the standard descaling rates (Table 3). Transported release groups showed no significant increase in the two-area descaling from that observed at the hatcheries prior to release and, in fact, one group from McCall Hatchery showed a decrease of 0.62 (Table 3).

Descaling of Steelhead Trout at Hatcheries and Release Sites

Standard descaling rate for steelhead trout at Niagara Springs and Hagerman NFH was 0.1% and 0.22, respectively {Table 4). These values compare closely to 1985 rates, 0.1% and 0%, and are less than the 1986 rates, 1.4% and 1.5%.

Scattered descaling of steelhead trout at Niagara Springs and Hagerman NFH showed a slight increase from 1986. Niagara Springs Hatchery in 1987 had scattered descaling rates of 4.3% as compared to 2.9% in 1986. Hagerman NFH in 1987 showed 3.2%; in 1986 it was 2.8%. There was a slight decrease in two-area descaling at the two hatcheries from 1986 to 1987. Niagara Springs in 1987 was 1.02 and in 1986 was 3.2%. Hagerman NFH in 1987 was 1.1% and in 1986 it was 3.6%. These differences in the percent of the descaling rates are small enough to be due to chance variability only and cannot be shown to be statistically significant.

Both scattered and two-area descaling rates at the observed off-hatchery release sites showed no detectable difference from the rates observed prior to release (Table 4). As with the samples taken from the chinook salmon at hatcheries and at release sites, the difference in descaling rates for steelhead trout at the hatchery and at release sites is minimal and is not influenced by the transport methods.

Chinook Salmon Descaling at Traps

Weekly standard descaling rates for yearling chinook salmon at the Snake River trap ranged from 0% to 15.9%, the peak occurring in late April. Standard descaling at the Clearwater River trap ranged from 1.2% in early April to 9.9% during the third week of April. The Salmon River trap had weekly extremes of 0.9% and 3.2% standard descaling the first and third week of April, respectively. Seasonal averages at the Snake and Clearwater River traps were up over the 1986 averages (Table 5). In 1987, the Snake River trap showed the highest average standard descaling in chinook salmon (10.4%) that has been observed at that trap. This value is somewhat exaggerated due to the trapping conditions encountered in 1987. The low water conditions and reduced velocity at the trap site had an influence on the fish captured; the descaled and weaker fish were captured at a greater rate than healthy fish. The 1987 descaling data for chinook salmon at the Snake River

Table 3. Chinook salmon descaling rates (percent) at hatcheries and release sites, 1987.

Hatchery (release site)	St4nOard	Two-area	Scattered .
Rapid River Hatchery	0.3	1.2	1.8
(Rapid River)			
McCall Hatchery	0.3	0.6	1.2
(S.F. Salmon R.)	0	0	0.3
Sawtooth Hatchery	No observation made at hatchery		
(Crooked River)	0.6	2.2	5.6
(White Sands Creek)	0.6	1.7	6.7
Rooskia NFH	0.3	1.7	4.6
(Clear Creek)			
Dworshak NFH	0.3	0.3	0
(N.F. Clearwater River)			

Table 4. Steelhead trout descaling rates (percent) at hatcheries and release sites, 1987.

Hatchery (release site)	Classical	Two-area	Scattered
Niagara Springs Hatchery	0.1	1.0	4.3
(Snake R. 8 Hells Canyon Dam)	0.7	0.7	4.6
(Pahsiaeroi River)	0	0.6	4.7
Hagerman NTH	0.2	1.1	3.2
(Salmon R. 8 Sawtooth Hat.)	0	0.3	2.6
(Slate Creek)	0	1.6	4.0

Table 5. Seasonal mean standard descaling rates (percent) for yearling chinook'salmon, hatchery steelhead trout, and wild steelhead trout at the Snake, Clearwater, and Salmon river traps, 1984 through 1987.

Species	Year	Salmon River	Snake River	Clearwater River
Yearling Chinook salmon				
	1984	4.5	2.5	1.5
	1985	2.4	2.6	0.6
	1986	-	3.8	0.7
	1987	2.0	10.4	4.3
Hatchery steelhead trout				
	1984	8.7	5.5	4.1
	1985	10.1	6.2	2.1
	1986	-	14.5	6.3
	1987	6.2	6.2	4.0
Wild steelhead trout				
	1984	2.1	1.4	0.4
	1985	0.7	0.8	0.7
	1986	-	2.7	0.8
	1987	2.5	3.3	1.3

trap should not be considered representative of the condition of the 1987 chinook outmigration due to the propensity of the trap to select for weaker fish when river velocities are very low.

Increases of standard descaling rates of chinook salmon catches at the Clearwater River trap were also greater than seen in previous years. There are several explanations for this increase. The first explanation is the fact that the live box on the Clearwater River trap was modified in 1987 and this modification caused some increased turbulence in the live box that resulted in increased descaling and stress on the fish. Another problem associated with the live box of the trap was the fact that the new design allowed for a greater retention of fish captured, and over crowding in the live box was a severe problem on several occasions when in excess of 10,000 fish were collected in one evening. The problems associated with the trap live box have been corrected and these problems are not expected to reoccur in the future.

Standard descaling rates observed at the Salmon River trap in 1987 were similar to descaling rates in 1985 and 55% less than rates in 1984. At 2.0% standard descaling, the Salmon River trap was the lowest of the three traps in 1987.

Weekly descaling rates of chinook salmon at Lower Granite Dam ranged from 1.1% in mid-July to 5.0% in early May. The average descaling rate at Lower Granite Dam for the 1987 season was 4.4%. This compares to an average rate of 3.5% in 1986.

There was no observed descaling of sub-yearling chinook salmon at any of the trap sites. Sub-yearling chinook salmon are not differentiated at Lower Granite Dam, due to the extreme difficulty in identifying age-0 chinook. Therefore, a comparison between descaling of sub-yearling chinook at the traps and Lower Granite Dam is not available.

Hatchery Steelhead Trout Descaling at Traps

Standard descaling of hatchery steelhead trout at both the Snake River and Clearwater River traps in 1987 decreased from 1986 and were similar to the rates seen in 1984 and 1985 (Table 5). The problems encountered with chinook salmon descaling at the Snake and Clearwater River traps was not witnessed in steelhead trout sampled in 1987. The weekly averages at the Snake River trap ranged from 3.3% to 11.8%, with the peak occurring in late May. The seasonal average was 6.2%.

The Clearwater River trap averaged 4.02 for the season and ranged weekly from 1.3% in late April to 18.5% the last week of June.

Hatchery steelhead trout sampled at the Salmon River trap showed standard descaling rates of 6.2% for the season average. This is the lowest seasonal rate yet observed at the Salmon River trap. Weekly rates ranged from 5.8% the end of April to 9.1% two weeks earlier.

Weekly descaling rates of hatchery steelhead trout at Lower Granite Dam ranged from 0.32 the first week of July to 4.42 in mid-May.

Wild Steelhead Trout Descaling at Traps

Standard descaling of wild steelhead trout at all three trap sites in 1987 was greater than the rates observed in previous years (Table 5). The increase in wild steelhead trout descaling while the hatchery contingent showed a decrease in descaling cannot be explained. The Snake River trap averaged 3.3% for the season, with a range of 1.8% to 5.6% occurring in early June and late April. The Clearwater River trap ranged from 0.3% to 16.7% in late April and late March, respectively, with a seasonal average of 1.3%. The Salmon River trap catch of wild steelhead trout showed a range in the weekly standard descaling rate of 2.3% in late April to 11.12 in late March. The seasonal average was 2.5%.

Descaling of wild steelhead trout at Lower Granite Dam during 1987 ranged from 0.72 the second week of June to 3.52 the second week of May.

When comparing standard descaling rates from 1984 to later years, it should be noted that the 1984 descaling criterion does not include fish that had scales missing in a longitudinal band (#9's). This condition was added in 1985 and increased the descaling rate slightly; therefore, the 1984 descaling rates are somewhat low relative to 1985, 1986, and 1987 rates.

Trap Efficiency

Snake River Trap

The Snake River trap daily catch of yearling chinook salmon was too low to mark fish for trap efficiency tests in 1987. About the same number of chinook salmon smolts passed the trap as in previous years, so the trap efficiency for chinook salmon must have been greatly reduced. A rough estimate of trap efficiency would be 10 to 30 times less than the 1.2% of previous years, although there is little data to substantiate this estimate.

The reduced trap catch in 1987 is attributed to low water velocities associated with the extremely low runoff conditions. A threshold water velocity of about 2 feet per second at the mouth of the trap is required before the trap will effectively collect chinook smolts. Velocity at the mouth of the trap rarely exceeded 2.3 feet per second and was generally near 1.5 feet per second during the 1987 field season.

The total catch of steelhead trout smolts at the Snake River trap was comparable to other years. Efficiency tests were not conducted due to sporadic and unpredictable catch rates and to poor condition of steelhead trout smolts. Smolt condition was especially poor in June when daily steelhead trout catch was over 1,000 fish. At this time, the steelhead trout smolts that were collected showed signs of starvation, possibly due to the large number of smolts that had stalled in Lower Granite Reservoir, due to the low flow year, and the intense competition for food.

Clearwater River Trap

Trap efficiency for yearling chinook salmon was tested a total of 24 times over a discharge range of 6,000 cfs to 33,000 cfs during the past four years: 1984 through 1987 (Table 6). Efficiency estimates ranged from 0.21% to 8.48%. An analysis of variance, with efficiency data normalized by the arcsin$\sqrt{x}$ transformation, showed no significant difference in trap efficiency between years, at the 0.05 level of significance (F=1.609, P=0.224). An analysis of variance of the slopes of the lines of the four years of data were tested and no significant difference was found between the slope (F=0.344, P=0.794). Discharge was added to the equation of efficiency and years to see if it had an effect on efficiency between years and again there was no significant difference (years F=0.775, P=0.525; discharge F=0.440 P=0.517). Since no significant difference was found, the four years of data were pooled to estimate trap efficiency. An analysis of variance showed no relationship between efficiency and discharge at the 0.05 level (F=2.886, P=0.106). The mean chinook salmon smolt trap efficiency was 2.182 with a 952 confidence interval of 0.172 at the Clearwater River trap:

$$\bar{x} \pm cl = 0.0218 \pm 0.0017.$$

Trap efficiency for hatchery steelhead trout was tested 11 times between 1985 and 1987 over a discharge range of 13,000 cfs to 33,000 cfs. Efficiency estimates ranged from 0.022 to 0.432 (Table 7). An analysis of variance, with efficiency data normalized by the arcsin$\sqrt{x}$ transformation, showed significant difference, at the 0.1 level, in efficiency between years (F=3.761, P=0.071). It's difficult to determine whether this relationship truly exists or if it is an artifact of small sample size. The slope of the lines of the three years of data were tested and no significant difference was found (F=1.035, P=0.421). Discharge was added to the equation to see if it had an effect on efficiency between years. The slope of the lines was not discernible from zero (F=2.633, P=0.149) but there was a significant difference in the relationship between efficiency and discharge by year (year F=5.670, P=0.034). It appears there is a year affect on efficiency when adjusted for discharge. Efficiency varied by year, below the 0.05 level of significance, only when the variable discharge was added to the equation. Because of the effect of year on

Table 6. Clearwater River trap efficiency tests for Chinook salmon smolts, 1984 through 1987.

Release date		Recaptures/ Mark	Efficiency	Mean Q (kcfs)
1984	4/5	4/418	0.0096	21
	4/21	13/806	0.0161	33
	4/25	3/489	0.0061	31
	5/10	14/453	0.0309	24
1985	3/25	14/607	0.0230	9
	3/30	45/1,511	0.0298	9
	4/5	6/1,079	0.0056	18
	4/9	2/940	0.0021	15
	4/16	7/929	0.0075	33
1986	3/27	9/1,555	0.0058	22
	4/2	8/1,714	0.0047	29
1987				
hatchery	3/20	43/2,160	0.0199	13
releases	4/22	50/2,000	0.0250	6
	4/7	165/1,945	0.0848	10
	4/13	74/2,000	0.0370	13
	4/20328	103/4,000	0.0258	18
trap	4/2	33/1,926	0.0171	6
caught	4/3	11/1,458	0.0075	8
	4/6	15/1,872	0.0080	9
	4/7	15/1,163	0.0129	10
	4/9	9/450	0.0200	12

Overall efficiency and 954 confidence limits:

0.0218 ± 0.0017

Limit as percent of estimate = 7.8%

Table 7. Clearwater River trap efficiency for steelhead trout smolts, 1985 through 1987.

Release date		Recaptures/ Mark	Efficiency	Mean Q (kcfs)
1985	5/7	2/464	0.0043 .	29
	5/11	1/384	0.0026	33
1986	4/14	7/4,140	0.0017	20
	4/30	1/4,190	0.0002	20
	5/7	2/4,260	0.0005	29
	5/11	5/4,247	0.0012	29
1987				
hatchery	4/13	6/4,071	0.0015	13
brands	4/20	9/4,060	0.0022	16
	4/28	2/4,000	0.0005	26
trap	4/21-22	6/1,604	0.0037	13
caught	4/24	2/775	0.0026	15

1987 efficiency and 95% confidence limits:

0.0021 ± 0.00085

Limit as percent of estimate = 40%.

efficiency, the data cannot be pooled, and the mean efficiency for 1987 was:

$$\bar{x} \pm cl = 0.0021 \pm 0.00085.$$

Salmon River Trap

Chinook salmon trap efficiency at the Salmon River trap has been estimated 15 times from 1984 through 1987 (Table 8). An analysis of variance with efficiency data, normalized by an arcsin$\sqrt{x}$ transformation showed no significant difference in trap efficiency between years at the 0.05 level of significance (F=1.693, P=0.225). The slope of the line of the three years of data were tested, and no significant difference was found between the slopes (F=0.813, P=0.474). Discharge was added to the equation to see if it had an effect on efficiency between years. This analysis showed that the slope of the lines was discernible from zero (F=16.366, P=0.002) and that there was a significant difference in trap efficiency between years which was due to the effect of discharge (F=10.635, P=0.003). Because of the differences in trap efficiency between years, the data cannot be pooled and the trap efficiency for 1987 was used:

$$\bar{x} \sqrt{} cl = 0.0085 \pm 0.0018.$$

An analysis of variance was conducted to see if there was a relationship between efficiency and discharge when only the 1987 data was used. The analysis showed there was a significant relationship at the 0.05 level (N=8, r^2=0.734, P=0.007) and that the equation for predicting efficiency was:

$$\arcsin\sqrt{\text{efficiency}} = 11.149 - 0.813 \text{ discharge}$$

The Salmon River trap captures too few steelhead trout smolts for trap efficiency tests. Therefore, in 1987, steelhead trout smolts were marked at hatcheries and transported to the Salmon River approximately 2 km upstream from the trap location and released for efficiency tests. Three such groups were released at approximately seven-day intervals. Mean steelhead trap efficiency at the Salmon River was 0.25%:

$$\bar{x} \pm cl = 0.0025 \pm 0.0009.$$

Not enough data points are available to do a regression between steelhead trap efficiency and discharge. It is difficult to perform more steelhead efficiency test with hatchery-marked fish because of the time involved in freeze branding, limited hatchery space to keep the individual groups separated, and the difficulty associated with transporting branded groups to the trap site.

Table 8. Salmon River trap efficiency tests for yearling Chinook salmon smolts, 1984, 1985 and 1987.

Release date		Recaptures/ Mark	Efficiency	Mean 0 (kcfs)
198	4/6-7	4/314	0.0127	9.2
	4/10-11	22/1270	0.0173	9.8
	4/13-17	11/1374	0.0080	10.8
198	4/4-5	7/423	0.0165	8.6
	4/7-9	23/1168	0.0197	9.8
	4/10-11	20/1288	0.0155	13.4
	4/28-30	4/538	0.0074	12.3
1987	3/28-31	31/1225	0.0253	4.4
	4/2-4	27/1502	0.0180	4.7
	4/6	5/1478	0.0034	6.6
	4/9	5/1467	0.0034	8.7
	4/12	8/1500	0.0053	8.4
	4/16-17	11/1534	0.0072	8.0
	4/20	3/1282	0.0023	11.7
	4/23	3/1024	0.0029	9.9

Overall efficiency and 95% confidence interval:

$x = 0.0106 \pm 0.0016$

Limit as percent of estimate = 15%

Travel Time and Migration Rates

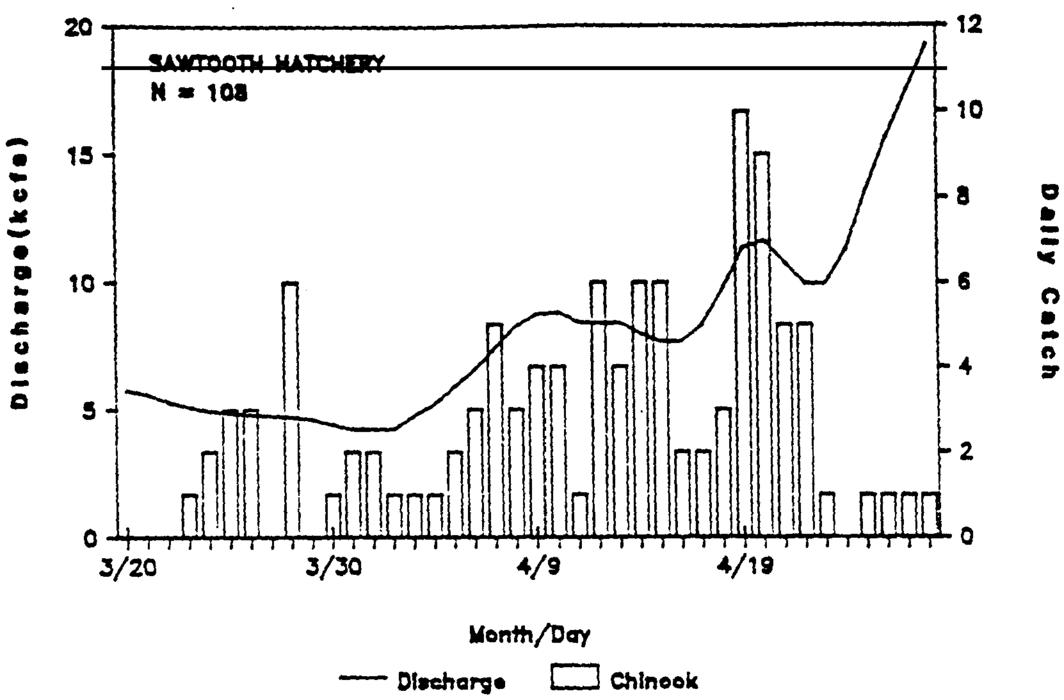
Release Sites to Salmon River Trap

Chinook salmon. There were four groups of freeze branded chinook salmon released in the Salmon River: one from Sawtooth Hatchery, one from South Fork Salmon River, and two groups from Rapid River Hatchery. Generally, only one freeze-branded group is released from Rapid River, but in 1987 the Hells Canyon freeze-brand group was accidentally mixed with the Rapid River fish. The combined mark groups were useful for determining travel time estimates in the Salmon River but useless for determining travel time between Hells Canyon and the Snake River trap.

Median release dates for branded chinook salmon at Sawtooth Hatchery, South Fork Salmon River, and Rapid River Hatchery were March 12, March 31, and April 2, respectively. Distances from point of release to the Salmon River trap are represented in Table 9. Branded chinook from the first Rapid River group began arriving on March 20, followed by the second Rapid River group on March 22. The Sawtooth group began arriving on March 23, and the South Fork Salmon River group on April 7 (Figs. 13 and 14). Median passage of these groups followed the same order, with both Rapid River groups passing on April 4, the Sawtooth group passing on April 13, and the South Fork Salmon River group passing on April 18.

The Sawtooth Hatchery chinook brand group migrated fastest (16.2 km/d), followed by the South Fork Salmon River group (13.0 km/d), and the two Rapid River groups (9.2 km/d). The 1987 travel time of the Sawtooth and South Fork Salmon River groups was similar to that observed in 1983. Average discharge during the migration period for the South Fork Salmon River group in 1983 and 1987 was the same and lowest of the four years examined (Table 10). Average discharge during the migration period for the Sawtooth Hatchery group was 3,500 cfs lower in 1987. The slow rate of movement of the Sawtooth group in 1987 may be attributed to lower than normal flows and an early release date. The Sawtooth chinook were released two weeks earlier than normal, and it is suspected that they moved very slowly until the water temperature warmed.

The majority of the two Rapid River brand groups passed the Salmon River trap with a 5,000 cfs increase in discharge that occurred from April 4 to 9 (Fig. 13). The South Fork Salmon River chinook brand group began moving with this same peak in discharge although they did not start to arrive until April 8. This is probably when the brand group first reached this portion of the river on their down stream migration. As this peak begins to subside, the South Fork fish movement slows. The South Fork brand group began moving again with the next peak in discharge, which occurred from April 17 to 24. Most of the South Fork Salmon River fish had passed the trap by April 24. The Sawtooth chinook brand group began arriving in large numbers earlier than the other brand groups (Fig. 13). The peak movement of the



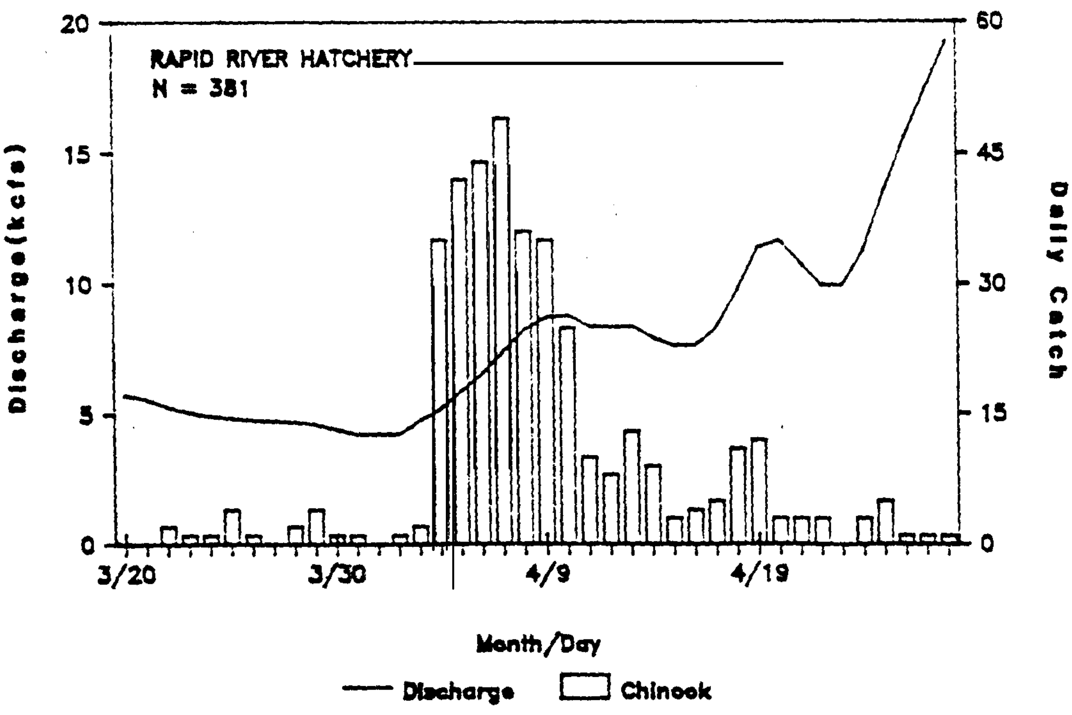


Figure 13. Daily catch for two unique hatchery chinook salmon brand groups at the Salmon River trap overlaid with Salmon River discharge, 1987.

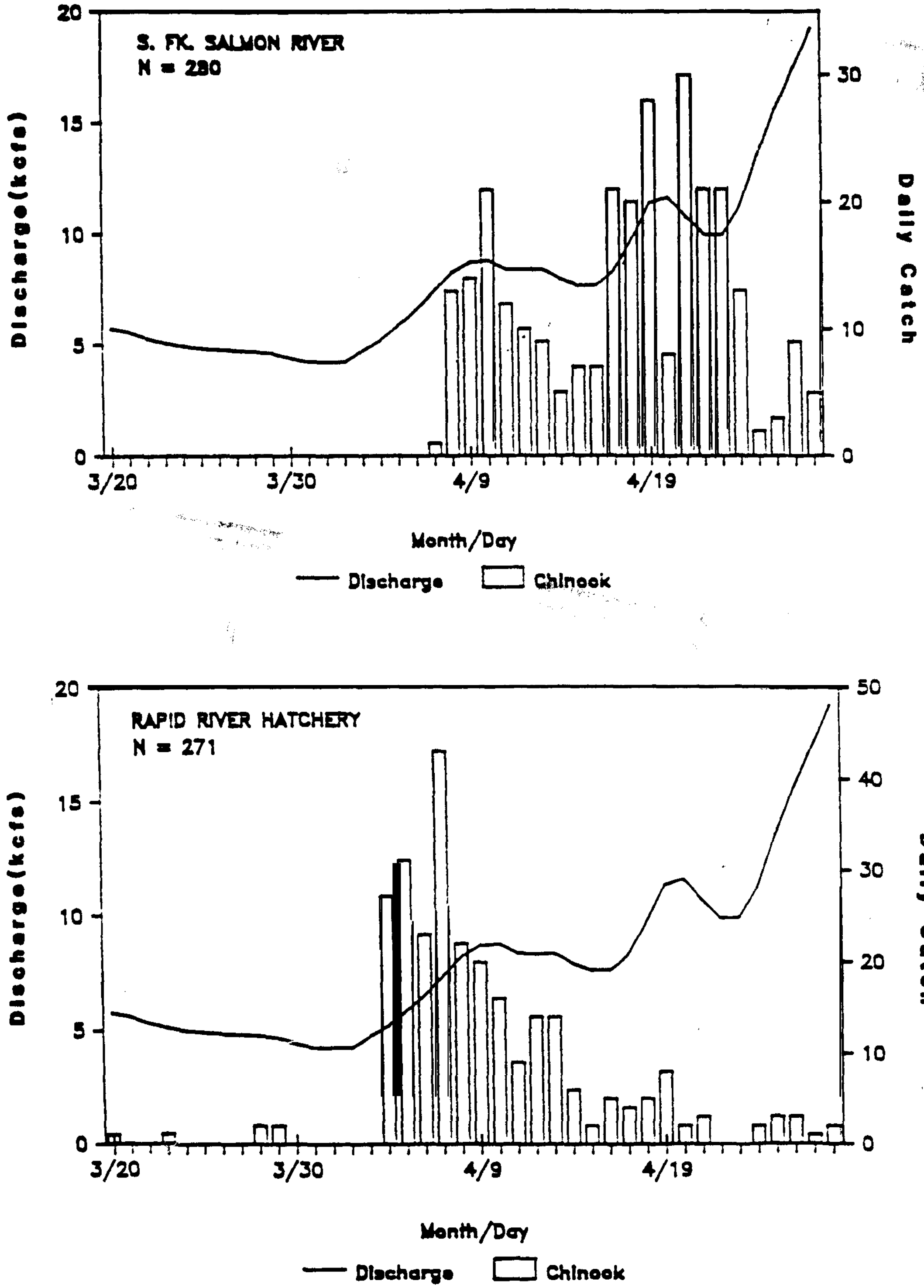


Figure 14. Daily catch for two unique hatchery chinook salmon brand groups at the Salmon River trap overlaid with Salmon River discharge, 1987.

Table 9. River mile & kilometer index for the Snake River Drainage.

	Mouth of Columbia R.		Mouth of Snake River		Lower Granite Dam		Snake River Trap Site		Clearwater R. Trap Site		Salmon River Trap Site	
	mi	km	mi	km	mi	km	mi	km	mi	km	mi	km
Mouth of Snake River	324.3	521.8	0.0	0.0	107.5	172.9	139.6	224.6	145.7	234.5	241.4	388.4
Lower Granite Dam	431.8	694.8	107.5	173.0	0.0	0.0	32.1	51.6	38.3	61.5	133.9	215.4
Clearwater R. Trap Site	470.0	756.2	145.7	234.4	38.2	61.5	-	-	0.0	0.0	-	-
Highway 95 Boat Launch	473.2	761.4	148.9	239.6	41.5	66.8	-	-	3.2	5.1	-	-
Dworshak NFH	504.2	811.3	179.9	289.5	72.4	116.5	-	-	34.2	55.0	-	-
Kooskia NFH	541.6	871.4	217.3	349.6	109.8	176.7	-	-	71.5	115.0	-	-
Crooked River	604.3	972.3	280.0	450.5	172.5	277.6	-	-	134.3	216.0	-	-
Red River Rearing Pond	618.0	994.4	293.7	472.6	186.2	299.6	-	-	148.0	238.1	-	-
Snake River Trap Site	463.9	746.4	139.6	224.6	32.1	51.6	0.0	0.0	-	-	101.8	163.8
Asotin Creek	469.6	755.6	145.3	233.8	37.8	60.8	5.7	9.2	-	-	-	-
Mouth of Grande Ronde R.	493.0	793.2	168.7	271.4	61.2	98.5	29.1	46.8	-	-	-	-
Cottonwood Creek	521.7	839.4	197.4	317.6	89.9	144.6	57.8	93.0	-	-	-	-
Lookingglass Creek	580.4	933.9	256.1	412.1	148.6	239.1	116.5	187.4	-	-	-	-
Big Canyon Creek	585.9	942.7	261.6	420.9	154.1	247.9	122.0	196.3	-	-	-	-
Spring Creek	614.4	988.6	290.1	466.8	182.6	293.8	150.5	242.2	-	-	-	-
Catherine Creek	636.9	1024.8	312.6	503.0	205.1	330.0	173.0	278.4	-	-	-	-
Mouth of Salmon River	512.5	824.6	188.2	302.8	80.7	129.8	48.6	78.2	-	-	53.2	85.6
Imnaha River	516.0	830.3	191.7	309.1	84.2	135.7	52.1	83.8	-	-	-	-
Little Sheep Creek	553.8	891.1	229.5	369.3	122.0	196.3	89.9	144.6	-	-	-	-
Imnaha Coll. Facility	565.6	910.2	241.3	388.3	133.8	215.4	101.7	163.6	-	-	-	-
Hells Canyon Dam	571.3	919.2	247.0	397.4	139.5	224.5	107.4	172.8	-	-	-	-
Salmon River Trap Site	565.7	910.2	241.4	388.4	133.9	215.4	101.8	163.8	-	-	0.0	0.0
Rapid River Hatchery	605.8	974.7	281.5	452.9	174.0	280.0	141.9	228.3	-	-	40.1	64.5
Hazard Creek	618.7	995.5	294.4	473.7	186.9	300.7	154.8	249.1	-	-	53.0	85.3
S.F. Salmon @Knox Bridge	719.7	1158.0	395.4	636.2	287.9	463.2	255.8	411.6	-	-	154.0	247.8
Pahsimeroi Hatchery	817.5	1315.4	493.2	793.6	385.7	620.6	353.6	568.9	-	-	251.8	405.1
E.F. Salmon @ Trap Site	873.6	1405.6	549.3	883.8	441.8	710.9	409.7	659.2	-	-	307.9	495.4
Sawtooth Hatchery	896.7	1444.2	573.3	922.4	465.8	749.5	433.7	697.8	-	-	331.9	534.0

Table 10. Migration statistics for branded chinook salmon smolts released at three sites on the Salmon River and migrating past the Salmon River trap, 1983 through 1987.

Release Sites	Dates Release	Dates Arrival	Distance (Km)	Migration rate (Km/day)	brands recap.	White Bird Mean Q (kcfs)
South Fork Salmon River						
	4/05/83	4/23/83	248	13.7	134	7.0
	4/10/84	4/19/84	248	27.5	108	12.6
	4/02/85	4/12/85	248	24.8	70	10.2
	3/31/87	4/18/87	248	13.0	280	7.1
			x = 19.8			
Sawtooth Hatchery						
	3/29/83	4/29/83	534	17.2	57	9.5
	3/28/84	4/19/84	534	24.3	124	10.2
	3/27/85	4/11/85	534	35.6	123	7.9
	3/12/87	4/13/87	534	16.3	108	6.0
			x = 23.4			
Rapid River						
	3/25/83	4/04/83	65	7.1	149	7.2
	4/01/84	4/13/84	65	5.3	286	8.8
	4/02/85	4/09/85	65	8.2	453	8.5
	4/02/87	4/08/87	65	9.2	381	6.1
	4/02/87	4/08/87	65	9.2	271	6.1
			x = 7.8			

Sawtooth brand group lagged behind changes in discharge by two to three days and again the majority of the brand group passed the trap by April 23.

Steelhead trout. Steelhead are not captured in large enough numbers to determine travel time from point of release to the Salmon River Trap.

Release Site to Snake River Trap

Due to extreme low discharge during the 1987 juvenile outmigration, the Snake River trap efficiency was very low (probably less than 0.012) and, therefore, the number of branded chinook collected was much lower than in previous years. As a result, travel time and migration rates could not be calculated between release points and the Snake River trap. Migration statistics for 1984 through 1986 are represented in Tables 11 and 12.

Release Site to the Clearwater Trap

Chinook salmon. One group of freeze-branded chinook salmon was released from Dworshak NFH on April 2, 1987. The travel time to the Clearwater River trap for this group was four days (Table 13). This compares to a travel time of one day for the two previous years (1985 & 1986). Average discharge during the migration period in 1987 was 7,200 cfs; 762 less than in 1986 (29,000 cfs) and 582 less than in 1985 (17,300 cfs). The extreme low discharge in 1987 is most likely responsible for the 752 reduction in travel time. Discharge at the time of the release was approximately 7,000 cfs (Fig. 15).

Steelhead trout. Three groups of freeze-branded steelhead trout were released above the Clearwater River trap in 1987. The Crooked River release group, the farthest upstream release group, was released on April 14 and had not passed the Clearwater River trap by April 29, when trapping was terminated for 22 days due to high water (Table 13). The Clear Creek group was released on April 17 and the travel time was four days (28.8 km/d). There is no previous information with which to compare these upriver releases. The Dworshak release was made from April 20 to 23. Because the release was made over a four-day period, migration rate cannot be calculated over such a short distance. Large numbers of branded steelhead were collected the day after releases; the travel time may be about one or two days (Fig. 16). In previous years, the travel time for the Dworshak group was one day.

Table 11. Migration statistics for freeze branded chinook smolts from release sites to the Snake River trap, 1984 through 1987.

Release site	Year	Median release date	Median passage date	Number captured	Travel time (days)	Migration rate (km/day)	Mean 0 (kcfs) Salmon R.	Snake P.
Rapid River	1987	1/						
	1986	3/27	4/10	237	14	16.3	15.4	82.9
	1985	4/2	4/12	320	10	22.8	10.6	67.6
	1984	4/1	4/18	197	17	13.4	10.1	79.3
Hells Canyon	1987	1/						
	1986	3/26	4/3	269	8	21.6	-	83.8
	1985	3/19	4/3	544	14	12.4	-	43.0
	1984	3/20	3/29	704	9	19.2	-	81.4
S.F. Salmon River	1987	1/						
	1986	3/28	4/23	229	26	15.8	16.5	78.6
	1985	4/2	4/17	76	15	27.1	14.0	71.0
	1984	4/10	4/24	238	14	29.0	14.5	91.7
Saiatooth Hatchery	1987	1/						
	1986	3/17	4/14	49	28	24.9	13.6	81.4
	1985	3/27	4/14	165	18	38.7	9.6	60.1
	1984	3/28	4/21	136	24	29.0	11.8	84.0
Lookingglass Cr.	1987	1/						
	1986	4/2	4/5	114	3	62.3		82.1
	1985	No marked release group.						
	1984	No marked release group.						

1/ Not enough recaptures at the Snake River trap.

Table 12. Migration statistics for freeze branded steelhead trout smolts from release sites to the Snake River trap, 1985 through 1987.

Release site	Year	Median release date	Median passage date	Number captured	Travel time (days)	Migration rate (km/day)	Mean Q (kcfs) Salmon R.	Mean Q (kcfs) Snake R.
Sawtooth Hatchery	1987	4/14	-	5	-	Not enough recaptures at the Snake R. trap.		
	1986	4/9	5/21	11	42	16.6	24.0	73.4
	1985	4/9	5/7	-	28	24.9	19.5	62.6
E.F. Salmon River	1987	4/8	-	5	-	Not enough recaptures at the Snake R. trap.		
	1986	4/8	5/24	9	45	14.6	24.7	73.9
	1985	4/17	5/1	-	22	30.0	20.6	56.4
Hells Canyon	1987	3/26	5/19	16	55	-	-	33.5
	1986	4/29	5/1	38	2	86.4	-	69.1
	1985	4/30	5/3	-	3	57.6	-	52.9
Spring Cr.	1987	4/26	-	-	-	Not enough recaptures at the Snake R. trap.		
	1986	5/1	5/27	14	26	9.3	-	72.9
		4/30	-	1	-	Not enough recaptures at the Snake R. trap.		
		4/3	-	2	-	Not enough recaptures at the Snake R. trap.		
	1985	5/9	5/19	-	10	24.2	-	46.4
Cottonwood Cr.	1987	4/26	4/30	28	5	-	-	39.3
	1986	4/28	5/5	110	13	13.0	-	72.3
		4/28	5/6	29	8	12.0	-	72.2
		4/28	5/5	42	7	13.0	-	72.3
Little Sheep Cr.	1987	5/2	-	-	-	Not enough recaptures at the Snake R. trap.		
	1986	4/28	5/8	16	10	12.0	-	72.1
		4/27	-	2	-	Not enough recaptures at the Snake R. trap.		

Table 13. Migration statistics for freeze branded chinook salmon and steelhead trout released above the Clearwater River trap, 1987.

Species	Release Site	Median Dates Release	Median Dates Passage	Number Released	Number Recap.	Migration rate Km/day	Travel Time	Mean Q (kcfs)
Chinook	Dworshak NFH	04/01	04/04	61,580	1416	13.8	4	7.2
Steelhead	Crooked River	04/14	-	48,557	2	-	-	-
Steelhead	Clear Creek	04/17	04/20	33,897	59	28.8	4	14.1
Steelhead	Dworshak NFH	04/21	04/22	43,081	58	-	-	-

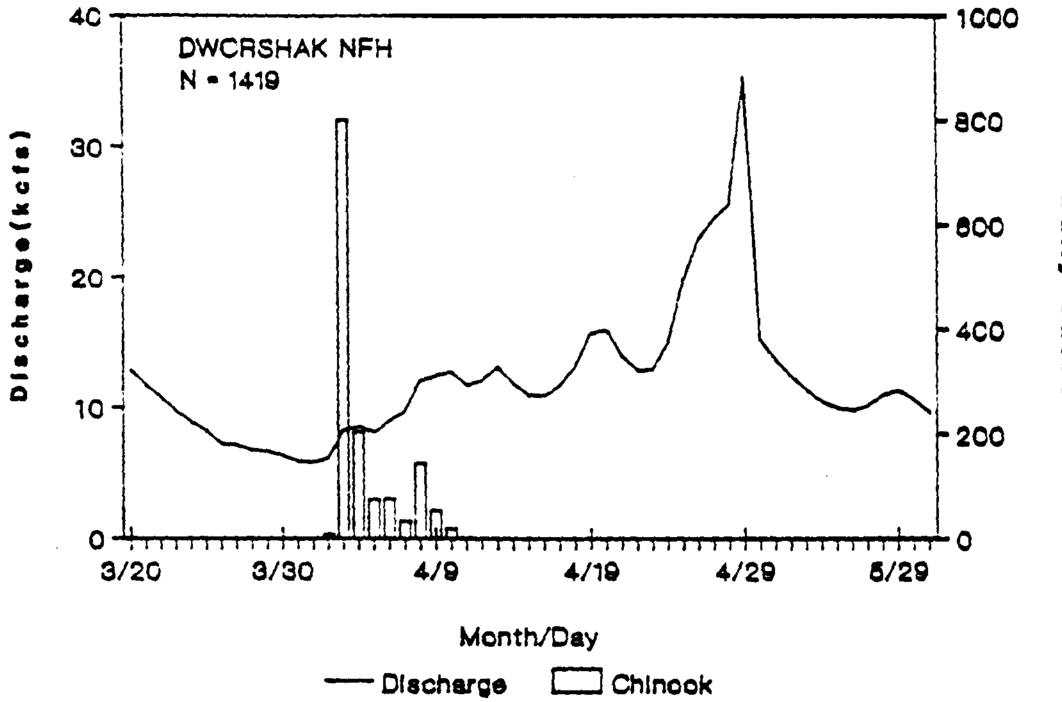
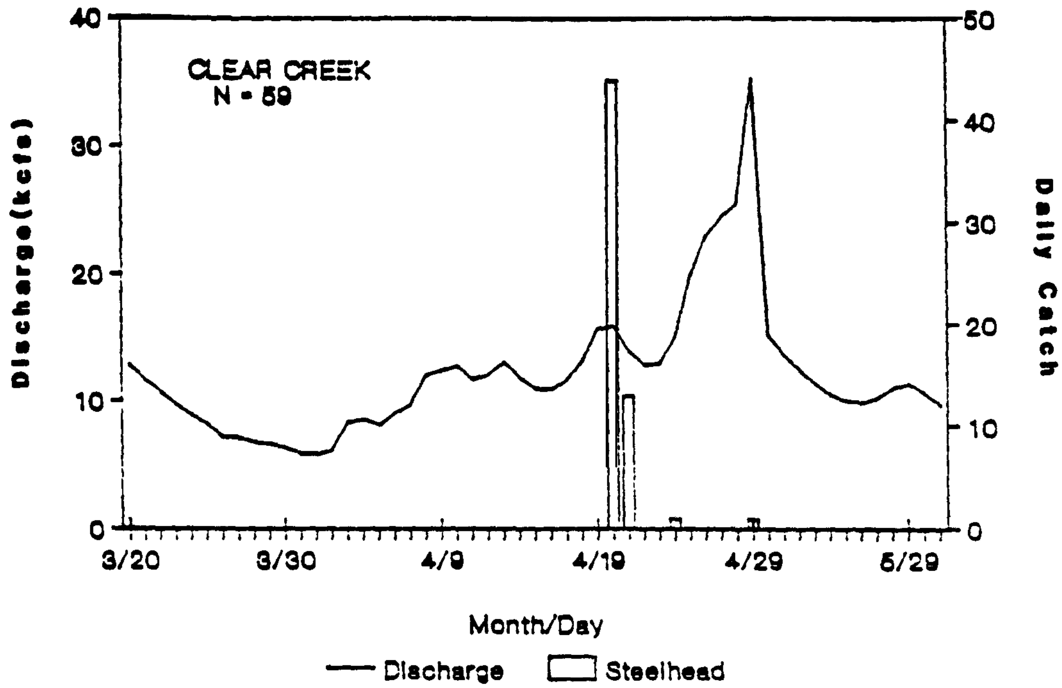


Figure 15. Daily catch of one unique chinook salmon brand groups at the Clearwater River trap overlaid with Clearwater River discharge, 1987.



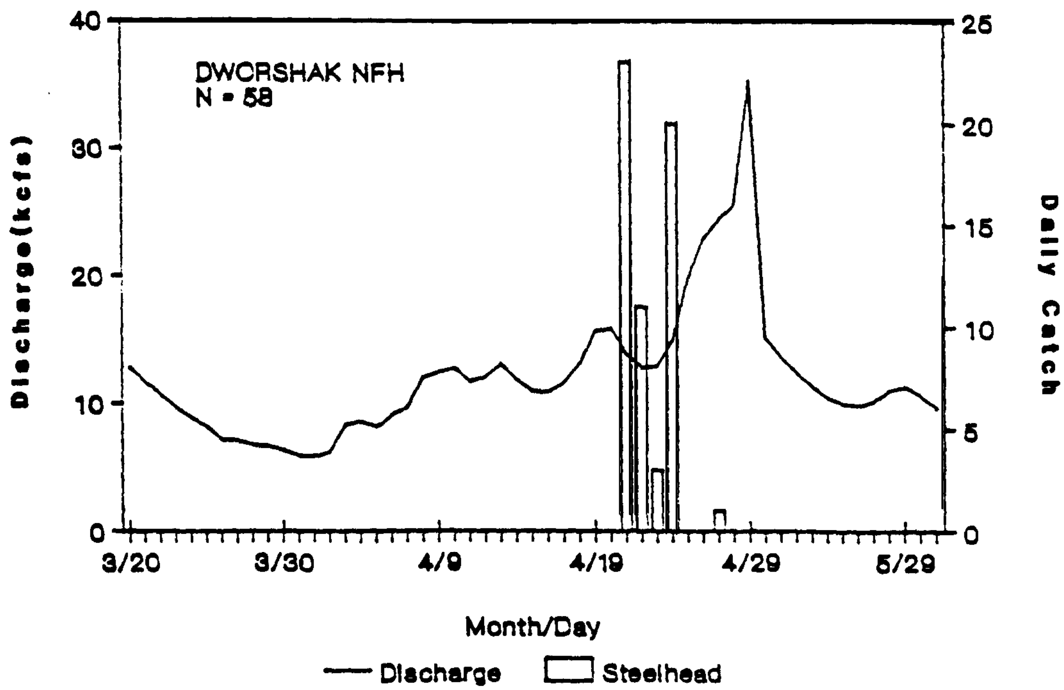


Figure 16. Daily catch of two unique steelhead trout brand groups at the Clearwater River trap overlaid with Clearwater River discharge, 1987.

Head of Lower Granite Reservoir to Lower Granite Dam

Chinook salmon freeze-brand groups. In 1987, only 5 of the 27 groups of freeze-branded chinook salmon could be used for travel time calculations through Lower Granite Reservoir because of the operational problems at the Snake River trap discussed earlier. All 5 of these groups were from the Clearwater River drainage. Average travel time from the Clearwater River to Lower Granite Dam for the Clearwater River chinook salmon freeze-brand group ranged from 13 to 30 days (Table 14).

Chinook salmon PIT-tag groups. In 1987, sufficient numbers of chinook salmon were PIT tagged (Prentice et al. 1987) daily at the Snake River trap to provide 25 groups (3,275 total) to estimate travel time and migration rate through Lower Granite Reservoir. Individual chinook salmon smolt travel times from the Snake River trap to Lower Granite Reservoir ranged from 4 to 22 days. Median travel time ranged from 22 days early in the migration season to 3 days late in the season (Table 15). There was a substantial change in median travel time between April 14 and April 22 related to an increase in discharge. Prior to April 14, the average median travel time through Lower Granite pool was 18.0 days (migration rate = 2.9 km/day) and after April 22 the average median travel time was 5.6 days (migration rate = 11.9 km/day). Average daily discharge for the PIT-tag groups released prior to April 14 was 33.5 kcfs and ranged from 31 to 41 kcfs. Average daily discharge for PIT-tag groups released after April 22 was 79.3 kcfs and ranged from 55 to 94 kcfs. A linear regression of travel time and discharge was calculated and showed a strong relationship between the two variables (N=24; $r^{2=}0.877$; P=0.000).

In an attempt to better illustrate the relationship, travel time and discharge were plotted on equal-interval scale graph paper. The relationship between the two variables was slightly curvilinear. Therefore, to linearize the relationship, several log transformations were tested and found that the linear regression of the log of travel time and discharge provides the best fit (N=24; r^2=0.938; p=0.000):

log median travel time = 3.863 - 0.027 average discharge.

PIT-tagged fish can be individually identified within each daily release group and, therefore, mean travel time can be calculated on a daily basis in addition to median travel time. Mean daily chinook travel time ranged from 23.1 to 3 days (2.2 km/day to 17.2 km/day). Mean daily travel time differed only slightly from median daily travel time. Early in the season, mean travel time was 23.1 days, while median travel time was 22.5 days. Late in the season, mean and median travel time was 3.0 days.

A linear regression analysis of mean travel time and discharge was done (n=24; r^2=0.956; P=0.000). There was only a slight difference in the coefficient of determination between mean and median travel time (mean r^2=0.956, median r^2=0.938).

Table 14. Chinook smolt travel time and migration rate to Lower Granite Dam from the head of Lower Granite pool using fish passing the Snake River trap from upriver releases, 1985 through 1987.

			Snake/Clearwater trap		Lower Granite Dam				
Year	Brand	Release Site	Median passage date	Number captured	Median arrival date LGD	Number captured	Travel time (days)	Migration rate (km/day)	Mean Q at LGD (kcfs)
1985	RDR-1	Sawtooth Hatchery	4/14	165	5/4	4,313	20	2.6	89
	RDR-3	S. F. Salmon River	4/17	76	5/14	4,193	27	1.9	85
	LDR-1	Rapid River	4/12	370	4/25	9,422	13	4.0	98
	LDR-3	Hells Canyon	4/3	544	4/13	7,111	10	5.1	88
	LDR-4	Grande Ronde River	6/4	135	6/23	6,868	19	2.7	79
	RDR-2	Dworshak NFH	4/4	248	4/27	6,403	23	2.7	94
1986	RAJ-1	Lookingglass Cr. (fall)	3/25	3	4/11	159	17	3.1	105
	RAJ-2	Lookingglass Cr.	4/5	38	4/14	3,741	9	5.8	99
	RAJ-3	Lookingglass Cr. (fall)	4/4	13	4/9	333	5	10.3	99
	RAJ-4	Lookingglass Cr.	4/5	76	4/21	2,593	16	3.2	95
	LDY-1	Rapid River	4/16	237	4/20	10,589	4	12.9	88
	LDY-3	Hells Canyon	4/3	269	4/16	9,898	13	4.0	100
	RAY-1	Dworshak NFH	4/2	312	4/21	4,703	19	3.2	97
	RDY-1	Sawtooth Hatchery	4/14	49	4/23	2,245	9	5.8	89
	RDY-3	S. F. Salmon River	4/23	229	5/3	5,921	10	5.1	98
1987	RAR-1	Dworshak NFH	4/4	1,416	4/24	11,069	21	5.1	37
	RD4-1	Clearwater River 1/	3/20	release	4/18	551	30	2.2	33
	RD4-3	Clearwater River 1/	4/2	release	4/20	436	19	3.5	35
	RA4-3	Clearwater River 1/	4/7	release	4/19	438	13	5.2	38
	RA4-1	Clearwater River 1/	4/13	release	4/29	334	17	3.9	46

1/ Releases made on Clearwater River at U.S. Highway 95 launch (Rkm-15.5).

Table 15. Chinook salmon PIT tag travel time, with 95% confidence intervals, from the head of Lower Granite Pool to Lower Granite Dam, 1987.

Release date	Median travel time (day)	Confidence Interval* Upper	Confidence Interval* Lower	Number captured	Percent captured (%)	Average discharge (kcfs)
03/23/87	19.0	25	17	14	23.3	31.5
03/24/87	21.0	24	17	31	33.0	32.2
03/25/87	20.0	22	16	31	32.6	31.9
03/26/87	21.0	24	20	30	29.7	31.9
03/27/87	21.0	23	19	35	29.9	32.1
03/30/87	22.5	25	18	24	28.9	34.1
03/31/87	18.5	22	17	36	36.0	33.1
04/01/87	18.0	19	17	33	28.9	34.2
04/02/87	18.0	20	16	76	39.4	35.2
04/03/87	19.0	22	17	65	31.6	36.1
04/06/87	19.0	20	17	75	36.1	38.1
04/07/87	17.0	18	15	57	31.3	38.0
04/08/87	18.0	21	15	59	29.2	39.3
04/09/87	18.0	20	16	49	28.5	40.1
04/10/87	15.0	16	13	55	34.6	38.7
04/13/87	11.0	13	10	20	26.3	38.2
04/14/87	13.0	15	12	33	30.8	41.3
04/22/87	8.0	9	7	12	26.1	55.3
04/28/87	4.0	4	3	85	37.4	87.4
04/30/87	3.0	4	3	54	21.2	93.6
05/01/87	5.0	7	4	134	43.5	81.9
05/04/87	6.0	8	4	22	40.0	80.0
05/05/87	7.0	9	4	10	40.0	77.7
05/06/87	6.5	12	4	8	38.1	79.0

* Confidence intervals calculated with nonparametric statistics

Percent recovery (integration) of daily release PIT-tagged chinook groups at Lower Granite Dam ranged between 20.91 and 43.5% and averaged 39.2%. Seasonal percent recovery of pit tagged chinook salmon to Lower Granite was 32.61, to Little Goose it was 42.9%, and to McNary it was 52.3%.

Hatchery steelhead trout freeze-brand groups. In 1987, median passage dates were calculated for four groups of freeze-branded steelhead trout at the Snake River trap and five groups at the Clearwater River trap. These groups were used to determine migration rate and travel time through Lower Granite Reservoir (Table 16). The earliest arriving freeze-brand groups at Lower Granite Reservoir migrated through the reservoir at the slowest rate: 15 to 5 days (4.1 to 10.3 km/d). The fastest moving groups in the reservoir entered Lower Granite Reservoir last (April 30) and migrated through the reservoir in five days (10.3 km/d).

The relationship between hatchery steelhead trout travel time through Lower Granite Reservoir and average discharge during each freeze-brand group migration was plotted on standard graph paper and showed **a** slight curvilinear relationship. Therefore, several linear regression models were calculated by logging both variables. The best fitting equation (N=7; r^2-0.846; P=0.003) was:

log travel time = 3.678 - 0.022 average discharge.

Hatchery steelhead trout PIT-tag groups. In 1987, sufficient numbers of hatchery steelhead trout were PIT tagged daily at the Snake River trap allowing 19 groups (827 individual fish) to be used in median migration rate calculations. Median travel time ranged from 10.5 to 2.0 days (4.7 km/d to 25.8 km/d) and averaged 4.7 days (Table 17). A linear regression analysis between median travel time in Lower Granite Pool and average Lower Granite discharge per PIT-tag group was conducted. The best linear regression equation (N=16; r^2=0.758; P=0.001) was:

median travel time = 31.773 - 6.406 log mean discharge.

The fact that only 761 of the variation in median travel time is accounted for by charge in discharge may be due to the low numbers of data points at discharges below 50,000 cfs. To remove some of the variability in the data and provide a more biologically meaningful relationship, averaged travel time was calculated by 10 kcfs discharge groups. A linear regression analysis was conducted and found that the best linear regression equation (N=6; r^2=0.892; P=0.005) was:

log average median travel time = 2.689 - 0.018 mean discharge.

The high coefficient of determination (r^2) indicates a strong relationship between hatchery steelhead trout median travel time through Lower Granite Reservoir and mean discharge. The low probability (P) indicates this relationship is highly significant.

Table 16. Steelheed trout smolt travel tine and nigration rate to Lower Granite Dan iron the head of Lower Granite pool, 1985 through 1987_

Yew	Brand	Release site	Snake/Clearwater River trap Median passage date	Snake/Clearwater River trap Nunber captured	lower Granite Den Median arrival date LGO	lower Granite Den Nunber captured	Travel tine (days)	Migration rate (kn/dey)	Mean U at LGD (kcfs)
1985	RDY-1	Sawtooth Hatchery	5/7	23	5/20	3,510	21	2.4	92
	RDY-3	E.F. Salnon River	5/9	22	5/28	2,454	19	2.7	93
	LDY-1	Hells Canyon	5/3	44	5/11	2,821	8	6.4	88
	RR17-1	Grande Ronde River	5/20	36	5/22	12,710	2	25.7	102
	RR17-3	Grande Ronde River	5/19	31	5/21	12,022	2	25.7	95
	LDY-2	Dworshak NFH	4/29	88	5/4	6,699	5	12.2	83
1986	RRIJ-1	Cottonwood Cr.	5/5	39	5/21	4,468	16	3.2	98
	RRIJ-3	Cottonwood Cr.	5/5	43	5/22	5,151	17	3.1	100
	RR1J-4	Cottonwood Cr.	5/6	29	5/10	4,114	12	4.3	99
	LRJ-1	Wallowa River	5/26	1	5/30	808	Not enough recaptures at Snake R. trap.		
	LRJ-3	Mallow% River	5/5	2	6/1	458	Not enough recaptures at Snake R. trap.		
	RRJ-1	Mellows River	5/27	14	5/26	1,628	Median arrival date at LOD one day before nedien passage date at Snake R. trap.		
	RRJ-2	Little Sheep Cr.	5/5	2	6/2	734	Not enough recaptures at Snake R. trap.		
	RRJ-3	Wallows River	5/8	2	5/30	1,326	Not enough recaptures at Snake R. trap.		
	RRJ-4	Little Sheep Cr.	5/8	16	5/30	1,340	22	2.4	114
	LDT-2	Sawtooth Hatchery	5/21	11	5/29	3,772	B	6.4	120
	LOT-4	E.F. Salmon River	5/23	9	5/29	1,552	6	8_5	119
	ROT-2	Hells Canyon	5/1	38	5/8	5,033	7	7.4	94
	RDT-4	Duorshak NFH	5/9	18	5/17	7,194	9	6.8	99
	L04-1	Clearwater R. Trap 1/	5/8	-	5/14	1,003	6	11.1	100
	LD4-3	Clearwater R. Trap 1/	5/13	-	5/22	069	9	7_4	98
	RD4-1	Clearwater R. Trap 1/	4/16	-	4/23	371	7	9.5	103
	R04-3	Clearwater R. Trap 1/	5/1	-	5/8	751	7	9.5	94
1987	RRIC-1	Cottonwood Cr.	4/30	7	5/4	4,886	5	10_3	06
	RRIC-2	Cottonwood Cr.	4/30	6	5/4	5,529	5	10_3	86
	RRIC-3	Cottonwood Cr.	4/30	7	5/4	5,971	5	10.3	86
	RRIC-4	Cottonwood Cr.	4/30	6	5/5	4,936	6	8_6	84
	RRR-3	Clear Cr.	4/20	59	5/1	3,500	15	4_1	59
	RDR-3	Dworshak NFH	4/22	58	5/1	4,917	10	6_2	63
	RDK-1	Clearwater R. Trap 1/	4/13	release	4/26	1,192	14	4_8	41
	RDA-2	Clearwater R. Trap 1/	4/20	release	4/30	999	11	6_1	56
	RDK-I	Clearwater R. Trap 1/	4/28	release	5/4	692	7	9_6	84

1/ Releases made on Clearwater River at U.S. Highway 95 launch (Rkn-15_5).

Table 17. Hatchery steelhead trout PIT tag travel time, with 95% confidence interval, from the head of Lower Granite pool to Lower Granite Dam, 1987.

Release date	Median travel time (day)	Confidence Interval* Upper	Lower	Number captured	Percent captured (%)	Average discharge (kcfs)
04/08/87	7.0	18	5	8	40.0	36.7
04/10/87	10.0	11	8	9	75.0	37.7
04/22/87	7.5	11	6	12	30.0	50.9
04/27/87	4.0	5	3	24	61.5	76.2
04/28/87	3.0	4	3	17	63.0	83.4
04/30/87	2.0	3	2	22	68.8	95.4
05/01/87	2.0	3	2	23	74.2	94.7
05/04/87	3.0	4	3	16	55.2	72.5
05/05/87	3.0	6	2	24	77.4	79.6
05/06/87	3.0	6	2	22	73.3	88.0
05/07/87	3.0	5	2	22	73.3	87.5
05/11/87	2.0	3	2	26	39.4	81.6
05/12/87	4.0	5	2	16	50.0	93.5
05/13/87	4.0	5	3	17	43.6	89.8
05/14/87	5.5	11	4	12	28.6	81.7
05/15/87	4.5	9	2	8	25.0	76.8
05/19/87	6.0	8	3	7	09.6	41.5
05/29/87	6.0	16	5	9	09.4	38.4
06/03/87	10.5	40	5	8	08.2	31.5

* Confidence intervals calculated with nonparametric statistics

PIT-tagged steelhead can be individually identified within each daily release group and, therefore, mean travel time and migration rate can be calculated in addition to median travel time and median migration rate. Mean hatchery steelhead travel time ranged from 14 to 2.5 days (3.6 km/d to 20.0 km/d) and averaged 5 days (10.3 km/d). A linear regression analysis between mean travel time in Lower Granite Reservoir and mean discharge at Lower Granite Dam was conducted. The best linear regression equation (N=19; r^2-0.602; P-0.000) was:

log travel time - 3.011 - 0.019 mean discharge.

The coefficient of determination (r^2) decreased significantly when mean travel time was used in the linear regression instead of median travel time (mean r^2=0.602, median r^2-0.892, respectively).

Percent recovery of daily hatchery steelhead PIT-tag release groups at Lower Granite Dam ranged from 6.32 to 77.4% and averaged 48.2%. Overall seasonal recovery of PIT-tagged hatchery steelhead to Lower Granite was 39.2%, to Little Goose it was 45.5%, and to McNary it was 46.3%.

Wild steelhead trout PIT-tag groups. In 1987, sufficient numbers of wild steelhead trout were PIT tagged at the Snake River trap to provide 12 daily PIT-tag groups (464 individual fish) for median travel time calculations (Table 18). This is the first time sufficient numbers of wild steelhead trout have been marked to provide travel time data to Lower Granite Dam. The PIT tag is the only tool available that can provide this type of data because of the low numbers of fish required for marking. Median migration rates for wild steelhead trout ranged from 7.9 km/d to 25.8 km/d and averaged 18 km/d. There is a difference in median migration rates between hatchery and wild steelhead trout. It is uncertain as to the reason for this difference. Two possible factors are that wild steelhead may be stronger and, therefore, travel faster and secondly, that the wild steelhead groups migrated through Lower Granite Reservoir when discharge was greater than did the hatchery steelhead trout groups. There were only 2 groups of wild steelhead trout that moved through Lower Granite Reservoir when average discharge was less than 70,000 cfs, while there were 7 groups of hatchery steelhead trout that migrated through the reservoir when average discharge was less than 70,000 cfs.

A linear regression analysis between median travel time in Lower Granite Reservoir and mean discharge for each PIT-tag group was conducted. The best linear regression equation (N-12; r^2-0,642; P=0.002) was:

median travel time = 24.901 - 5.009 log mean discharge.

Therefore, 64% of the variation in median travel time can be accounted for by discharge.

An analysis of the slopes of the four sets of data, the freeze-brand data, the hatchery steelhead trout PIT-tag data, the wild steelhead trout PIT-tag data, and the average travel time by 10,000 cfs

Table 18. Wild steelhead trout PIT tag travel time, with 95% confidence intervals, from the head of Lower Granite pool to Lower Granite Dam, 1987.

Release date	Median travel time (day)	Confidence Interval* Upper	Confidence Interval* Lower	Number captured	Percent captured (%)	Average discharge (kcfs)
04/22/87	6.5	12	6	8	23.5	47.3
04/27/87	3.0	4	2	11	57.9	71.1
04/28/87	3.0	3	2	36	70.6	23.4
04/30/87	2.0	3	2	16	55.2	95.4
05/01/87	2.0	3	2	18	58.1	94.7
05/04/87	3.0	4	2	21	70.0	72.5
05/05/87	2.0	3	2	18	60.0	72.1
05/06/87	3.0	3	2	13	52.0	88.0
05/07/87	3.5	4	2	18	62.1	87.5
05/11/87	2.0	2	2	20	41.7	81.6
05/12/87	2.0	3	2	19	52.8	96.2
05/13/87	3.0	5	2	9	56.2	93.1

* Confidence intervals calculated with nonparametric statistics

intervals for hatchery steelhead trout PIT-tag data was conducted to see if there was a significant difference between the slopes (Fig. 17). The analysis of variance showed there was a significant difference between the slopes (F=4.499, P=0.009). Figure 17 indicates the freeze-brand data provides the slope that is different as the freeze-brand data was removed from the data and the analysis was run again. This time there was not a significant difference in the slopes of the three lines (F=0.667, P=0.520). The PIT-tag data provides a broader relationship between travel time and average discharge than the freeze-brand data because of the ability to release more marked groups over a wider range of discharge. This may make the PIT-tag data much more valuable for travel time information to Lower Granite Dam.

PIT-tagged wild steelhead trout can be individually identified within each daily release group and, therefore, mean travel time can be calculated on a daily basis, in addition to median travel time. Mean daily wild steelhead migration rate ranged from 6.5 km/d to 22.1 km/d and averaged 17.4 km/d. A linear regression analysis between mean travel time in Lower Granite Reservoir and mean discharge at Lower Granite Dam was conducted. The best linear regression equation (N=12; r^2=0.701; P=0.001)was:

log mean travel time = 8.700 - 1.711 log mean discharge.

The coefficient of determination (r^2) was not improved when mean travel time was used in the linear regression instead of median travel time (mean r^2=0.701, median r^2=0.642, respectively).

Percent recovery of daily wild steelhead trout PIT-tag release groups at Lower Granite Dam ranged from 23.4% to 70.6% and averaged 56.4%. Overall seasonal recovery of PIT-tagged wild steelhead trout to Lower Granite Dam was 49.4%, to Little Goose it was 59.7%, and to McNary it was 61.4%. This compares with hatchery steelhead trout which had 48.2% and 39.2% recovery rates for daily and seasonal recovery to lower Granite Dam, respectively. Recovery of hatchery steelhead trout dropped off toward the end of the migration period, after May 13.

A linear regression analysis was not conducted on average wild steelhead trout travel time that was broken down by 10,000 cfs increments because of the low number of data points (N=4).

Release Site to Lower Granite Dam

Chinook salmon. There were 26 chinook salmon freeze-brand groups released above Lower Granite Dam in 1987. Migration rates ranged from an average of 3.7 km/d for the four groups of Dworshak Hatchery fish released 5.6 km above the Clearwater River trap (trap efficiency test groups) to 19.6 km/d for two groups of fish marked at the Salmon River trap and 19.9 km/d for the two groups released in Lookingglass Creek, Oregon (Table 19). At release sites, where multiple groups were released over time (Salmon and Clearwater River traps), we found an inverse relationship between migration rate and time of release. The

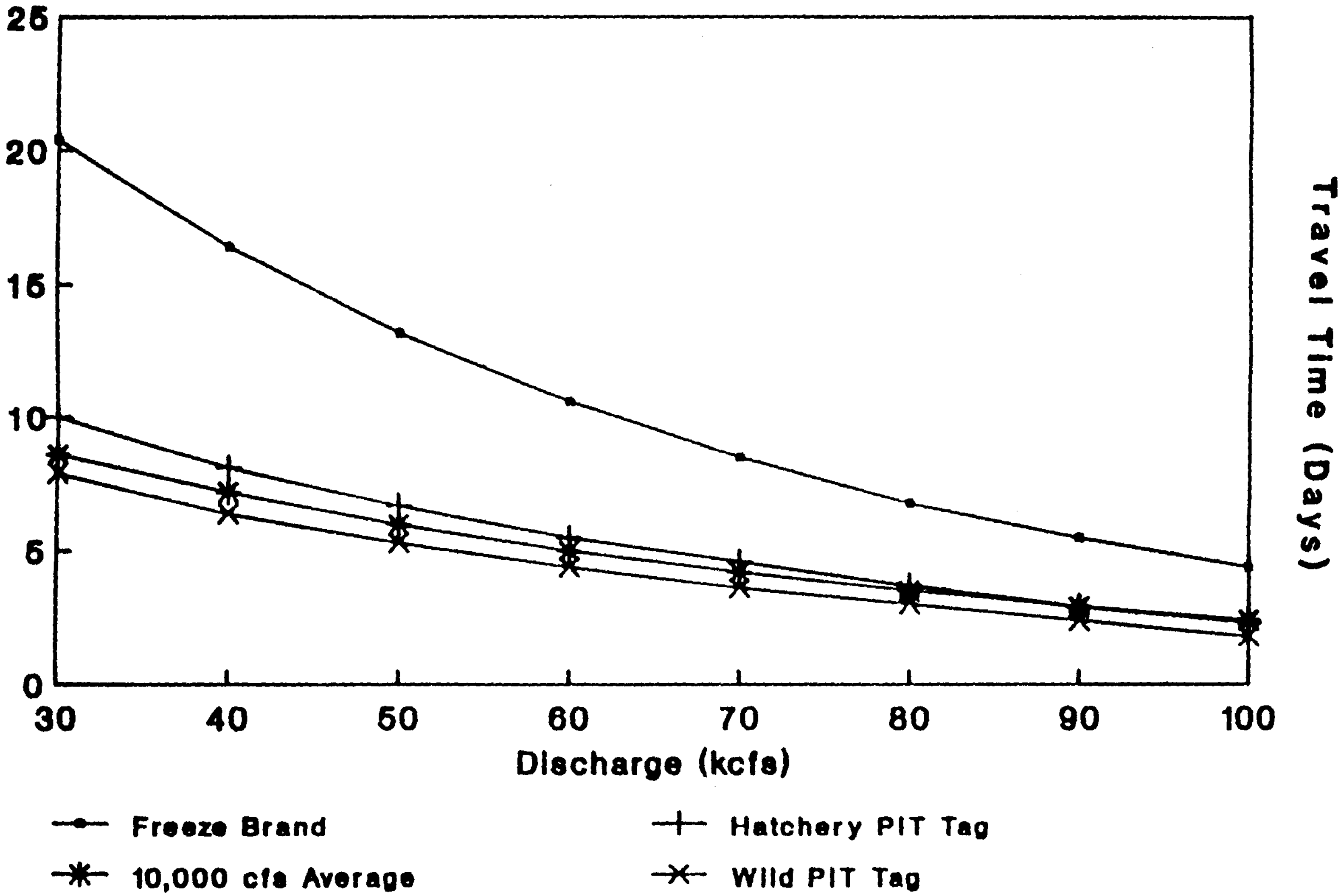


Fig. 17 Relationship between travel time through Lower Granite Reservoir and discharge for freeze branded, PIT tagged and migration rate averaged by 10,000 cfs groups for hatchery steelhead and PIT tagged wild steelhead trout, 1987.

Table 19. Migration statistics for branded chinook salmon from point of release to Lower Granite Dam, 1987.

Release Site	Median Release	Median Passage	Number Recaptured	Percent Recovered	Migration Rate Km/day	Travel Time	Mean Discharge
Sawtooth Hatchery	03/13/87	04/27/87	1128	1.90	16.30	46.00	37.08
South Fork Salmon R.	03/31/87	05/02/87	1956	3.50	14.00	33.00	45.00
Rapid River Hatchery	03/27/87	04/26/87	3867	7.20	9.03	31.00	35.84
Salmon River Trap	03/30/87	04/21/87	434	30.80	9.40	23.00	34.33
Salmon River Trap	04/04/87	04/23/87	1975	34.00	10.80	20.00	36.71
Salmon River Trap	04/07/87	04/25/87	1089	18.10	11.30	19.00	39.18
Salmon River Trap	04/09/87	04/29/87	908	14.50	10.30	21.00	44.57
Salmon River Trap	04/13/87	04/28/87	1089	18.90	13.50	16.00	43.69
Salmon River Trap	04/18/87	05/01/87	1234	20.50	15.40	14.00	57.06
Salmon River Trap	04/21/87	05/01/87	1098	20.00	19.60	11.00	61.15
Salmon River Trap	04/25/87	05/04/87	393	9.60	18.60	10.00	74.87
Lookingglass Creek	04/01/87	04/23/87	2488	12.30	10.40	23.00	35.36
Lookingglass Creek	04/01/87	04/24/87	2531	12.40	10.00	24.00	35.88
Lookingglass Creek	04/20/87	05/01/87	899	4.30	19.90	12.00	59.25
Lookingglass Creek	04/20/87	05/01/87	1012	4.80	19.90	12.00	59.25
Lookingglass Creek	05/20/87	06/13/87	1929	9.50	10.00	25.00	35.26
Lookingglass Creek	05/20/87	06/14/87	1919	9.40	9.60	26.00	34.92
Dworshak NFH	04/02/87	04/24/87	11069	18.00	5.10	23.00	36.33
Hwy. 95 Launch	03/20/87	04/18/87	551	25.50	2.20	30.00	33.86
Hwy. 95 Launch	04/02/87	04/20/87	436	21.80	3.50	19.00	35.34
Hwy. 95 Launch	04/07/87	04/19/87	438	22.50	5.20	13.00	37.73
Hwy. 95 Launch	04/13/87	04/29/87	334	16.70	3.90	17.00	46.20

fastest moving migrants had the latest release dates. This coincides with increased discharge at Lower Granite Dam and **a** higher degree of smoltification in these later fish. A linear regression of migration rate and Lower Granite Dam discharge was calculated on the eight groups of freeze-branded chinook salmon released from the Salmon River trap and showed that 94% of the variation in migration rate was accounted for by changes in discharge (r^2=0.944). This is mainly attributed to an increase in migration rate over time in Lower Granite Pool, which will be discussed later in this report. Migration rate was also related to the distance from the release site to Lower Granite Dam. The freeze-brand groups released the greatest distance from Lower Granite Dam migrated at the fastest rate. These fish spend more time in the free flowing sections of the river, where migration rate is much greater than in Lower Granite Pool, than do fish released closer to the reservoir.

Chinook salmon travel time and average Lower Granite discharge for the median migration period was calculated from point of release to Lower Granite Dam for chinook brand groups from 1985 through 1987 (Table 20). The general chinook outmigration was slightly slower in 1987, an extreme low water year, than in the two previous years. Discharge at Lower Granite Dam does not correlate well with travel time from point of release to Lower Granite Dam because of the large distances between release site and the collection facility at Lower Granite Dam. A large portion of a migrant's time is spent in streams in which discharge may not be well represented by discharge at Lower Granite Dam.

Steelhead trout. There were 25 hatchery steelhead trout freeze-brand groups released above Lower Granite Reservoir in 1987. Migration rate ranged from 6.8 km/d for the Hells Canyon group to an average of 33.6 km/d for four groups released from the Wallowa Hatchery (Table 21). Discharge at Lower Granite Dam during the migration period ranged from 36,000 cfs to 84,000 cfs.

Multiple groups of freeze-branded steelhead trout were released from both the Clearwater and Salmon River traps over a two-week period. Migration rates for the later released groups were more than twice as fast as for the earliest released groups. This is probably a factor of increased discharge during the migration period and a higher level of smoltification for the later groups (Muir et al. 1987).

Hatchery steelhead trout travel time and average Lower Granite discharge for the median migration period was calculated and compared from point of release to Lower Granite Dam for freeze-brand groups released in 1985 through 1987 (Table 22). In 1987, most of the steelhead trout freeze-brand groups median passage times at Lower Granite Dam were in early May, whereas in 1986 and 1985 the median passage was in mid to late May. The difference in travel time between these years may be due to the fact that in 1987, after the peak in discharge in early May, flows quickly dropped to below 30,000 cfs and never exceeded that level again during the migration season. If the migration season was truncated, as it was in 1987, then travel time would be shorter than in a more normal year when the migration season

Table 20. Chinooksalmon smolt travel time and migration rate from point of release to Lower Granite Dam,1985-1987.

Release Site	Travel time (Days) and Mean Discharge (kcfs) 1985 Days	kcfs	1986 Days	kc+s	1987 Days	kc+s
Sawtooth Hatchery	40	79.03	38	101.93	46	37.08
S. F. Salmon River	42	85.41	37	97.94	33	45.00
Rapid River	23	90.48	25	99.66	31	35.84
Hells Canyon	26	64.92	22	102.00	34	35.09
Lookingglass Cr.			13	101.52	23	35.36
Lookingglass Cr.			20	96.82	24	35.88
Dworshak NFH	24	89.54	20	96.82	23	36.33

Table 21. Migration statistics for branded steelheed trout from point of release to Lauer Granite Dan, 1987.

Release Site	Median Release	Median Passage	Number Recaptured	Percent Recovered	Migration Rate Km/day	Travel Time	Mean Discharge
Sautooth Hatchery	04/14/87	05/11/87	490	1.10	26.00	28.00	61.61
Salnon River Trap	04/08/87	05/03/87	1188	25.30	8.30	26.00	51.21
Salmon River Trap	04/15/87	05/07/87	905	20.50	9.40	23.00	60.30
Salnon River Trap	04/22/87	05/03/87	1011	21.60	18.00	12.00	66.70
Hells Canyon	03/26/87	04/27/87	3185	6.20	6.80	33.00	36.23
Wallowa NFH	04/26/87	05/03/87	489	3.30	36.70	8.00	70.00
Wallowa NFH	04/26/87	05/03/87	169	1.20	36.70	8.00	78.00
Wallowa NFH	04/26/87	05/03/87	402	3.30	36.70	8.00	78.00
Wallowa NFH	04/26/87	05/07/87	185	1.30	24.50	12.00	78.01
Cottonwood Creek	04/26/87	05/04/87	5529	27.50	16.10	9.00	77.47
Cottonwood Creek	04/26/87	05/04/87	5971	29.70	16.10	9_00	77.47
Cottonwood Creek	04/26/87	05/04/87	4886	24.30	16.10	9.00	77.47
Cottonwood Creek	04/26/87	05/05/87	4936	24.50	14.50	10.00	76.74
Crooked River	04/14/87	05/23/87	2363	4.90	6.90	40.00	63.51
Clear Creek	04/17/87	05/01/87	3500	10.30	11.80	15.00	55.99
Dworshak NFH	04/22/87	05/01/87	4917	11.40	11.70	10.00	63.34
Dworshak NFH	05/05/87	05/10/87	406	10.00	19.40	6.00	79.32
Hwy 95 Boat Launch	04/13/87	04/26/87	1192	29.30	4.80	14.00	40.86
Hwy 95 Boat Launch	04/20/87	04/30/87	999	24.60	6.10	11.00	55.61
Hwy 95 float Launch	04/28/87	05/04/87	692	17.30	9.60	7.00	84.26

Table 22. Steelhead trout travel time and migration rate from point of release to Lower Granite Dam, 1985-1987.

	Travel time (Days) and Mean Discharge (kcfs)					
	1985		1986		1987	
Release Site	Days	kcfs	Days	kcfs	Days	kcfs
Sawtooth Hatchery	50	89.83	51	101.39	2B	61.61
E. F. Salmon River	42	88.01	52	101.31	43	61.61
Hells Canyon	12	85.32	30	95.32	33	36.23
Little Sheep Cr.			36	116.07		
Little Sheep Cr.			33	107.53		
Spring Creek			31	108.46	8	78.00
Spring Creek			33	114.60	8	78.00
Spring Creek			26	99.38	8	78.00
Spring Creek			29	109.64	12	78.01
Cottonwood Cr.	14	82.22	24	96.50	9	77.47
Cottonwood Cr.	13	80.49	25	97.60	9	77.47
Cottonwood Cr.			21	95.22	9	77.47
Cottonwood Cr.					10	76.74
Dworshak NFH	6	81.98	11	97.65	10	63.34

generally lasts until about the first of June. Fish did not really move faster in 1987, but the portion of the population that normally migrates in the later part of the migration season stalled in Lower Granite Reservoir.

Release date also plays an important role in travel time. Travel time for the Hells Canyon group in 1987 and 1986 was about a month and this group was released on March 26 in 1987 and April 9 in 1986. In 1985, travel time for this group was 12 days and the release date was April 30.

Steelhead Trout Radio Tracking

Snake River

The first release of six radio-tagged hatchery steelhead trout smolts in the Snake River was made on April 29. Six additional releases of nine fish each were made through May 5, for a total of 60 fish. Of these, 48 were tracked through the study area. The majority of these fish, 45, passed under the interstate bridge at the middle or east spans. Only three of the tagged fish were tracked under the west span in the vicinity of the trap (Fig. 18).

Liscom and Bartlett's (1988) major conclusions of the Snake River tracking effort were:

1. The major migration route for steelhead trout was through the middle and eastern spans of the Lewiston-Clarkston Interstate Bridge (the trap was located under the west span).
2. Insufficient numbers of fish passed near the trap to determine if there was a trap avoidance problem.

Clearwater River

Radio tracking on the Clearwater River began April 20, when six radio-tagged hatchery steelhead trout smolts were released 5.6 km upstream from the trap site. Over the next four days, releases continued until a total of 61 radio-tagged fish had been released. Of these, 35 were tracked at the trap site. Two of these fish passed the trap on the north side of the river, 25 passed on the south side, and 8 swam directly toward the trap but avoided it (Fig. 18).

The major conclusions of Liscom and Bartlett regarding the Clearwater River radio tracking effort were:

1. The major migration route taken by steelhead trout was between the trap and the south shore.
2. There appeared to be trap avoidance.

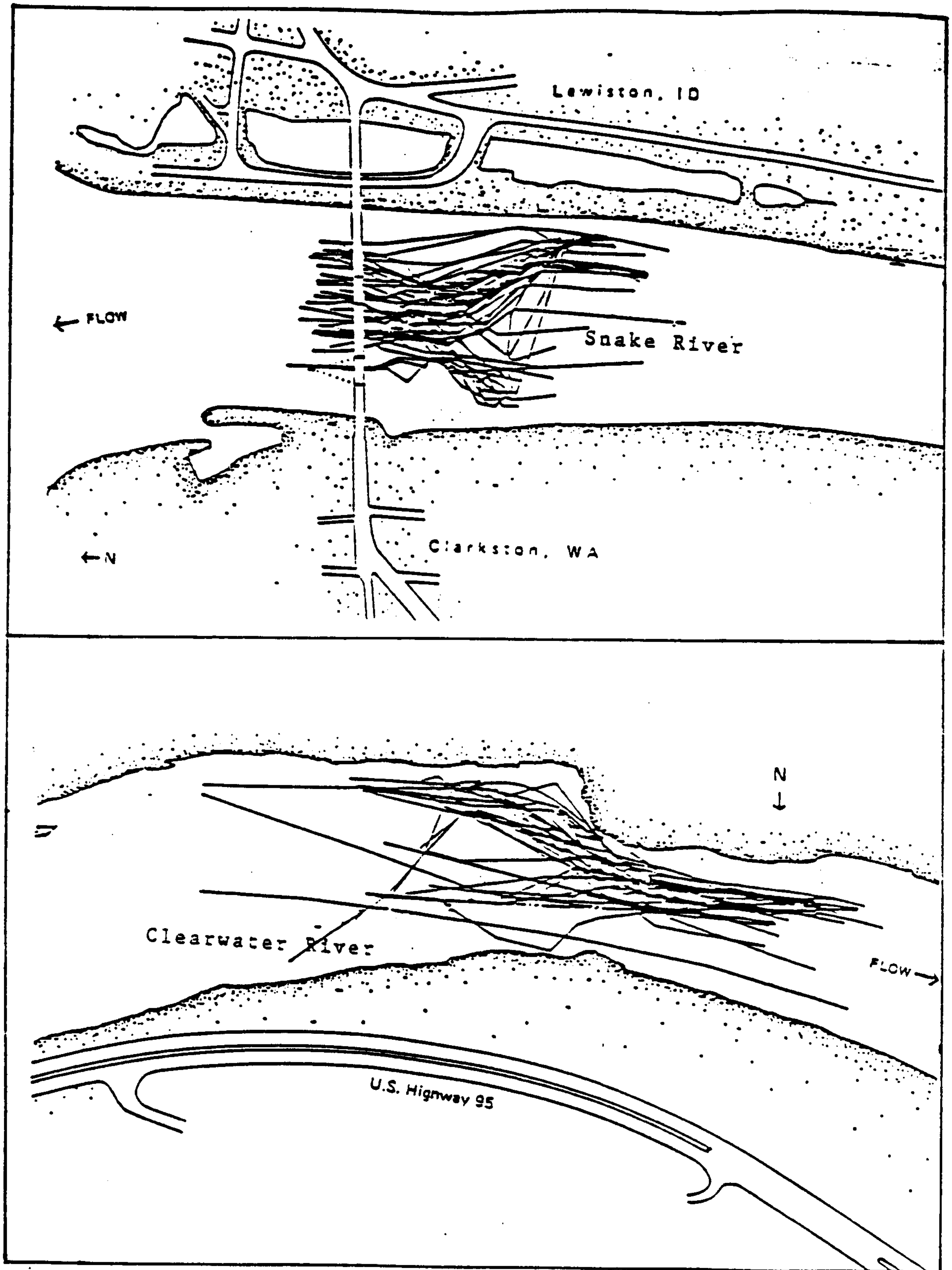


Figure 18. Composite of 48 radio tracks on the Snake River and 35 radio tracks on the Clearwater River completed on juvenile steelhead trout, 1987.

SUMMARY

In addition to wild and natural chinook salmon and steelhead trout production, 11,291,583 chinook salmon and 7,436,384 steelhead trout juveniles were reared at hatcheries in Idaho, Oregon, and Washington for release upriver from Lower Granite Reservoir contributing to the 1987 outmigration. Of these, 445,385 chinook salmon and 489,671 steelhead trout smolts (3.9% and 6.6% of the total release, respectively) were freeze branded and released in 13 unique groups for chinook salmon and 21 unique groups for steelhead trout.

The Snake River trap operated from February 28 through June 29. The Snake River trap captured 1,887 yearling chinook salmon, 56 sub-yearling chinook salmon, 935 wild steelhead trout, 8,754 hatchery steelhead trout, and 5 sockeye salmon. Approximately 0.02% {67) of the hatchery-branded steelhead trout smolts released in the Snake River drainage upstream from the Snake River trap were captured by the Snake River trap. The Snake River trap did not catch more branded chinook salmon in 1987 because of the extremely low water conditions.

Average migration rate from point of release to the Snake River trap for hatchery-branded chinook salmon in 1987 was not calculated because of lack of data, due to the low water conditions. Average migration rate for branded chinook salmon from the Snake River trap to Lower Granite Dam in 1987 was, again, not calculated due to lack of data. Average migration rate from the Snake River trap to Lower Granite Dam was determined with the PIT tag. Prior to April 14 median travel time was 18.0 *days* and discharge was below 40.0 kcfs. After April 22, the average medial travel time was five days, and mean discharge was above 50.0 kcfs. Because of the low number of branded steelhead trout captured in the Snake River trap in 1987, average migration rate from point of release to the Snake River trap was not calculated. Average migration rate from the Snake River trap to Lower Granite Dam was estimated in 1987 using the PIT tag. Average migration rate from the Snake River trap to Lower Granite Reservoir in 1987 was similar to the migration rate in 1985 but was twice as fast as it was in 1986 (13.6 km/d in 1987, 6.6 km/d in 1986 and 12.5 km/d in 1985). Two branded steelhead trout groups released in the Grande Ronde River in 1985 greatly skewed the data. If the average migration rates are calculated without these two groups, the 1986 movement is slightly faster than 1985, 6.6 km/d in 1986 and 5.9 km/d in 1985 and the 1987 movement was twice as fast as either of the previous years. Freeze-branded steelhead trout smolts move approximately three to four times faster in the free flowing river section than they do in Lower Granite Reservoir.

There was little temporal overlap in the passage of yearling chinook salmon smolts and steelhead trout smolts at the Snake River trap. The majority of the chinook salmon passed in April and most of the steelhead trout in May.

The Clearwater River trap operated from February 19 to April 29 and again from May 20 to June 25. The trap captured 72,707 yearling chinook salmon smolts, 5,567 hatchery steelhead trout smolts, and 896 wild steelhead trout smolts. The ratio of wild to hatchery steelhead trout smolts in the Clearwater River trap catch was about 1:6. Freeze-branded chinook salmon smolts released form Dworshak NFH generally have an average migration rate to the Clearwater River trap of one day (migration rate - 57 km/d), but in 1987, the average migration rate was 13.8 km/d.

The Salmon River trap was operated from March 5 to April 28. The Salmon River trap catch was 51,557 yearling chinook salmon, 46 sub-yearling chinook salmon, 598 wild steelhead trout, and 615 hatchery steelhead trout. The wild-hatchery steelhead trout ratio for the Salmon River trap cannot be calculated from this data because the trap operation was terminated prior to the major hatchery steelhead trout movement. The majority of the chinook passed the trap in April and the wild and hatchery steelhead trap catch was on the increase when trap operation was terminated the end of April.

No correlation between discharge and trap efficiency was detected at any of the traps. Mean trap efficiency for yearling chinook salmon and steelhead trout smolts at the Snake River trap was 1.20% and 0.67%, respectively. Mean trap efficiency for yearling chinook salmon and steelhead trout smolts at the Clearwater River trap was 2.18% and 0.132, respectively. Mean trap efficiency for yearling chinook salmon and steelhead trout at the Salmon River trap was 1.06% and 0.25%, respectively.

Average weekly standard descaling rates for yearling chinook salmon smolts was 10.4% at the Snake River trap, 4.3% at the Clearwater River trap, and 2.0% at the Salmon River trap. The extremely high average standard descaling observed at the Snake River trap is not representative of the overall chinook salmon population in the head of Lower Granite Reservoir. Average standard descaling for hatchery steelhead trout at all three traps was similar to previous years. Wild steelhead trout average classical (standard) descaling was slightly higher than in previous years. Descaling of hatchery steelhead trout smolts was much greater than that seen in wild steelhead trout smolts at all three traps.

Descaling of chinook salmon and steelhead trout smolts at hatcheries was less than 0.52. There was no noticeable increase in descaling for chinook salmon or steelhead trout due to transportation from hatchery to release site. Degree of scale loss is likely associated with illness or other stresses fish have undergone prior to being transported. There is, however, a question of what happens to the fish after they have been released into the stream system. The rate of descaling that occurs to hatchery fish unfamiliar with stream hazards is not fully known and may contribute greatly to the descaling and mortality of these fish.

LITERATURE CITED

Koski, C.H., S.W. Pettit, J.B. Athearn, and A.L. Heindl. 1986. Fish Transportation Oversight Annual Team Report - FY 1985. Transport Operations on the Snake and Columbia Rivers. NOAA Technical Memorandum NMFS F/NWR - 14. U.S. Department of Commerce.

Liscom, K.L. and C. Bartlett. 1988. Radio Tracking to Determine Steelhead Trout Smolt Migration Patterns at the Clearwater and Snake River Migrant Traps Near Lewiston, Idaho. Final Report to Idaho Department of Fish and Game. Contract No. R7FSO88BM. 67 P.

Mason, J.E. 1966. The Migrant Dipper: A Trap for Downstream Migrating Fish. Progressive Fish Culturist. 28:96-102.

Mighell, J.L. 1969. Rapid Cold-Branding of Salmon and Trout with Liquid Nitrogen. Journal of Fishery Research Board of Canada. 26:2765-2769.

Muir, W.D., A.E. Giorgi, W.S. Zaugg, W.W. Dickhoff, B.R. Beckman. 1987. Behavior and Physiology Study in Relation to Fish Guidance at Lower Granite and Little Goose Dams. Annual Report of Research to the Army Corps of Engineers. In Press.

Prentice, E.F., T.A. Flagg, and S. McCutcheon. 1987. A Study to Determine the Biological Feasibility of a New Fish Tagging System, 1986-1987. U.S. Dept.of Commer., Natl. Oceanic and Atmos. Admin., Natl. marine Fish. Serv., Northwest and Alaska Dish. Cent., Seattle, Wa. 113 p. (Report to Bonneville Power Administration, Contract DE-179-83BP11982, Project 83-19).

Ott, L. 1977. An Introduction to Statistical Methods and Data Analysis. Duxbury Press, North Scituate, Massachusetts.

Raymond, H.L. and G.B. Collins. 1974. Techniques for Appraisal of Migrating Juvenile Anadromous Fish Populations in the Columbia River Basin. IN: Symposium on Methodology for the Survey, Monitoring and Appraisal of Fishery Resources in Lakes and Large Rivers, May 2-4, 1974. Aviemore, Scotland. Food and Agricultural Organization of the United Nations, European Inland Fisheries Advisory Commission, EIFAC/74/I/Symposium-24, Rome, Italy.

Submitted by:

Edwin W. Buettner
Sr. Fishery Research Biologist

V. Lance Nelson
Sr. Fishery Technician

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Jerry M. Conley, Director

Steven M. Huffaker, Chief
Bureau of Fisheries

Dexter Pitman
Anadromous Fisheries Manager